INTERAVIA

Review of World Aviation

In this Issue:

Bombers and Space Weapons

Arthur Shay : The AAF Fights the Weather

Alexander Klemin : Aileron Combinations — N. J. Hoff : Monocoque Construction

Martin XB-48 — Blackburn S. 28/43 — Boeing Gas Turbines

Georges Février : Flight to the Antilles

VOLUME II Nº 8 AUGUST, 1947

GENÈVE-*Cointrin*

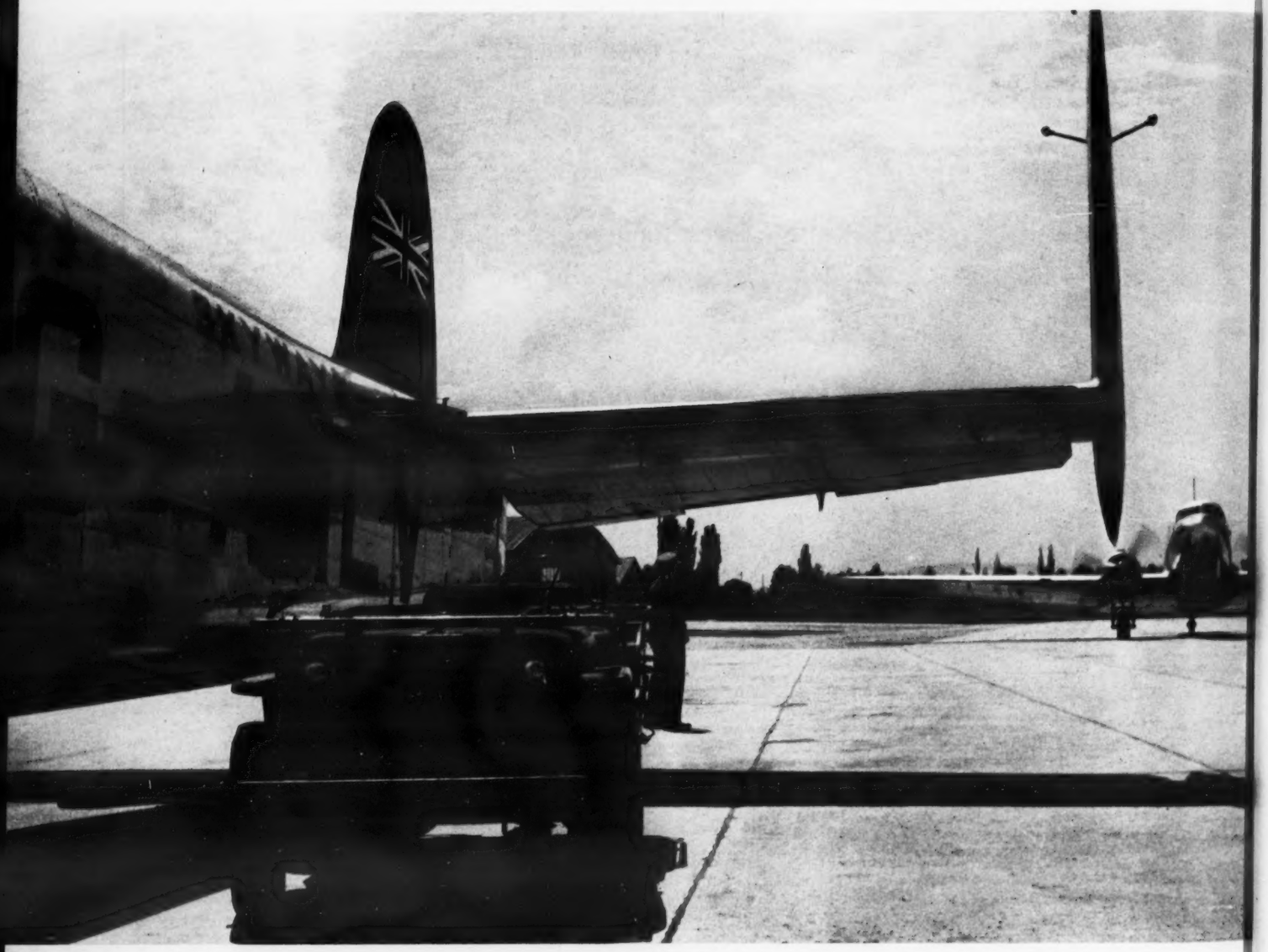


Photo Motard, Genève

Cointrin Airport, Geneva, the crossroads of European airways

ONLY RUNWAY IN SWITZERLAND SUITABLE FOR INTER-CONTINENTAL TRAFFIC

RUNWAY LENGTH, 6500 ft.

INTERAVIA

Review of World Aviation

OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F. A. I.)

Volume II | August 1947 | No. 8

Board of Directors : Marcel Devaud, Edgar Primault, E. E. Heiman, H. O. C. Messner, E. V. D. Wight, Jr.

Editors : E. E. Heiman. H. T. Biland, E. de Tavel, E. Herzfeld.

Assistant Editors : Patrick A. Sauter, E. Cherbuliez, J. Jenny, F. Podzorski, A. Arbex, O. Bertholin y Gálvez, E. Baur.

Art Editor : H. W. Mahrer.

Advertising : Percy A. Blackburn.

Publishers and Distributors : Interavia S. A. **Proprietors :** Volamecum S. A.

Contents

Marginal Notes		**11**
Bombers and Space Weapons		**12**
Flight to the Antilles	GEORGES FÉVRIER	**19**
Blackburn S. 28/43		**23**
The Air Hostess Told Us		**26**
Aileron Combinations (Concluded)	A. KLEMIN	**27**
Electricity on the "Stratocruiser"		**32**
Monocoque Construction (Concluded)	N. J. HOFF	**33**
Cross-Wind Landing Gear		**37**
Boeing Builds Gas Turbines		**40**
The AAF Fights the Weather	ARTHUR SHAY	**44**
Building Aircraft Underground		**49**
Martin XB-48		**51**
Airline Hotels		**53**
Book Review		**56**
Month in Review		**57**

Front Cover : V2 takes off

Appears Monthly in Four Editions : English, French, Spanish and German.

Publishing and Editorial Offices, Subscription Department : Interavia S. A., 20, Cité, Geneva.

Advertising Department: 13, Corraterie, Geneva. Telephones : 5.42.32, 5.42.33 and 5.42.34. Cables and Telegrams : Interavia-Geneva.

Prices: Switzerland : annual subscription, Sw. frs. 20.00; single copy, Sw. frs. 2.00. Annual subscriptions in other countries : U. S. A., $ 8.00; Great Britain, £ 2 0s 0d; France, Fr. frs. 1,000.00; Belgium, belg. frs. 350.00; Denmark. Kr. 40; Argentina, $ m/n 35.00; all other countries, Sw. frs. 30.00.

Agents and Distributing Offices:

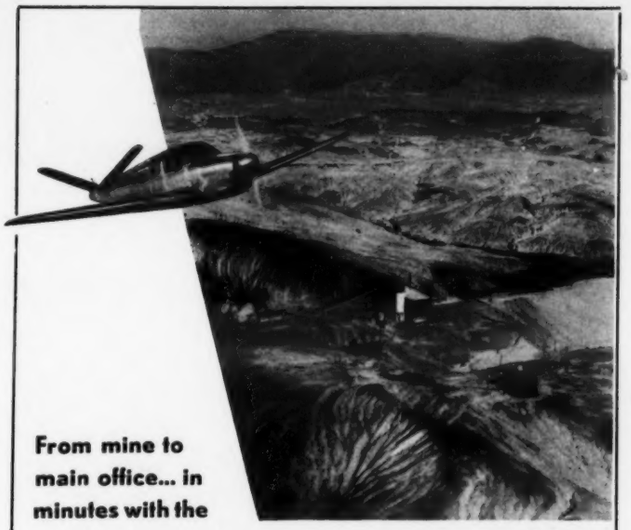
INTERAVIA BELGIUM :	11 Rue de Crayer, Brussels, or Office de Publicité, 36 Rue Neuve, Brussels.
INTERAVIA DENMARK :	Daemningen 21, Copenhagen/Valby. Dansk Centralagentur, Stormgade 20, Copenhagen.
INTERAVIA FRANCE :	6 Place de la Madeleine, Paris 2e.
INTERAVIA GREAT BRITAIN :	Eagle House, 109 Jermyn Street, London S. W. 1.
INTERAVIA HOLLAND :	9 Drienerparkweg, Hengelo (O) or M. van Gelderen & Zn., Postbox 826, Amsterdam-C.
INTERAVIA HUNGARY :	Ibusz, V. Vigador-tér 2, Budapest.
INTERAVIA IRELAND :	33 Kildare Street, Dublin.
INTERAVIA ITALY :	39 Viale di Villa Massimo, Rome.
INTERAVIA SPAIN :	Velásquez 87 or Lista 60, Madrid.
INTERAVIA SWEDEN :	Postbox 29, Linköping.
INTERAVIA U. S. A. :	292 Madison Avenue, Room 902, New York, N.Y.
INTERAVIA ARGENTINA :	Charcas 2745, Buenos Aires.
INTERAVIA BRAZIL :	38 Rua Teofilo Otoni, Rio de Janeiro.
INTERAVIA EGYPT :	B. P. 134, Cairo.

Copyright 1947 by Interavia S. A., Geneva, Switzerland

Printed in Switzerland

Imprimeries Populaires, Geneva — Héliographia S. A., Lausanne

Imprimerie "Tribune de Genève", Geneva



From mine to main office... in minutes with the

BEECHCRAFT BONANZA

The mine may be located on a distant plateau or in some mountain fastness. But within a matter of minutes, or possibly an hour, a Beechcraft Bonanza can bring key personnel within daily personal contact of the centers on which the mine depends for existence. Home office executives can conserve time and energy, covering far-flung interests with ease and speed. The supplier of equipment can send his salesmen or his products quickly and directly to the mine. Ore samples, mail, repairs, the sick or injured—all are carried safely, rapidly, at low cost—by the Bonanza.

The new Bonanza is a four-place, 172 mph business vehicle that brings travel costs to as low as one cent per passenger mile while providing limousine quietness and luxury. Equipped for round-the-season, round-the-clock operation with radio, landing lights, instruments, flaps, controllable prop. Range, 750 miles.

*

The Bonanza is capable of saving thousands of dollars a year in man-hours and executive efficiency. Write for complete information and the name of the nearest Beechcraft distributor.

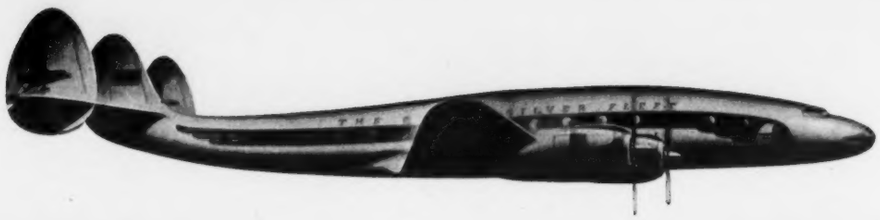
Executive Transportation · Exploration
Drilling and Production
Equipment Transportation
Marketing and Sales

Beechcraft Executive Transport Model 18

Twin engines, 200 mph speed, up to nine persons, luxuriously appointed. More than 300 in daily use for private transportation by the world's leading industries.

Beech Aircraft

CORPORATION WICHITA, KANSAS, U. S. A.



New Type

Lockheed Constellation

...World's Most Modern Airliner

—Capt. Eddie Rickenbacker

„We of Eastern Air Lines could have chosen any of the large airliners. After months of study and comparison, we decided on the new-type Constellations. We did so because we are convinced that they are beyond a doubt the world's fastest, most powerful, dependable and comfortable, the world's most modern airliners."

Eddie V. Rickenbacker

Leader over the Atlantic — The "Constellation"

Flying the Atlantic is the supreme test of airliner efficiency and dependability. For many months past, the majority of these daily flights have been Constel'ation flights. As of May 15, Constellations were flying 80 Atlantic round trips per week—more than any other scheduled transport.

Endorsed and chosen by distinguished airlines all over the world, this newest version of the famous Constellation brings a new kind of flying pleasure to air travelers everywhere.

MORE THOROUGHLY PROVEN. The proof is in the flying. Behind the Lockheed Constellation lie nearly a billion passenger miles of commercial service plus thousands of hours of operational experience for pilots, flight personnel and ground crews. Thus the Constellation is already the most thoroughly proven of the largest modern air transports.

FIRST CHOICE OF LEADING AIRLINES *and world travelers on : Aer Lingus — Aerlinte Eireann (Irish Air Lines) — Air France — American Overseas Airlines—British Overseas Airways Corp.—Eastern Air Lines—KLM Royal Dutch Airlines—KNILM Royal Netherlands Indies' Airways—L.A.V. (Linea Aeropostal Venezolana)—Panair Do Brasil—Pan American World Airways—Qantas Empire Airways Ltd.—Trans World Airline.*

Now more than ever-World Leader

Lockheed Constellation

LOOK TO LOCKHEED FOR LEADERSHIP — YEARS AHEAD IN THE SCIENCE OF FLIGHT

How the New MARTIN Transports can

CUT COSTS AND BUILD TRAFFIC FOR AIRLINES

HIGH PERFORMANCE

Here's why 15 world-famous airlines have purchased Martin 2-0-2 and 3-0-3 airliners..... why these advanced new commercial transports are becoming standard for airlines everywhere. These Martin transport cruise at speeds 100 m.p.h. faster than twin-engined transports now in use, carrying greater loads at higher altitudes. Even with one engine inoperative, the 2-0-2 (gross weight 38,000 lbs.) can fly faster than can present twin-engined transports with *both* engines operating. The 3-0-3 will offer comfortable high-speed cruising at altitudes of more than 5 miles above the earth.

ECONOMY OF OPERATION

These efficient twin-engined planes offer such improvements as under-fuselage hatches for ease of maintenance, under-wing refueling, 40-passenger payload, heat anti-icing, reversible pitch propellers, ability to take off and land on smaller airfields. Operating costs are unusually low. Passengers enjoy the roomy adjustable seats, advanced ventilation and heating, individual reading lights, sound-conditioning and other features.

QUANTITY PRODUCTION

Holding orders for more new transports than any other manufacturer, Martin is in quantity production, with resultant low cost to airlines. Moreover, Martin stresses close technical cooperation with purchasing airlines. For example, a large training school is now in operation at the Martin plants to train pilots and maintenance crews in the use of the new Martin transports.

BUILT BY MARTIN

These two ultra-modern planes are built by The Glenn L. Martin Company, oldest and largest aircraft manufacturer in the U. S. Incorporating 39 years of research and experience, they're the world's finest postwar airlines. The Glenn L. Martin Company, Baltimore 3, Md., U. S. A.

IN FLIGHT TESTS, Martin 2-0-2's are exceeding anticipated performance. Pressurized sister ship, the Martin 3-0-3, is being rushed to completion.

GLENN L.

Martin

AIRCRAFT

Builders of Dependable *Aircraft Since 1909*

THESE LEADING AIRLINES ARE EQUIPPING WITH NEW MARTIN TRANSPORTS

Capital Airlines (PCA) • Eastern Air Lines • Chicago and Southern Air Lines • United Air Lines
Northwest Airlines • Delta Air Lines • Pan American-Grace Airways (Panagra) • Servicos Aereos Cruzeiro do Sul (Brazil)
Compañia Aeroposta Argentina • Linea Aérea Nacional (Chile) • Mutual • Flying Tiger Line
Air Borne Cargo Lines • U. S. Airlines • Willis Air Service

DICTAPHONE Belt Recording machines installed at Washington National Airport, Washington, D. C., U. S. A.

What are they saying over the U.S. Capital?

Pilot to Control Tower: "....."

Control Tower to Pilot: "....."

To fill in the actual dialogue, you have only to check the files of the Washington National Airport, Washington, D. C.

There, on individual plastic belts, are the actual spoken words. Thanks to Dictaphone Belt Recorders you can play back the entire conversation—or have it transcribed for future reference!

Major U. S. Airports
Now Use Dictaphone Belt Recorders

Over 400 of these recorders have been installed in air traffic control centers operated by the U.S. Government!

Dictaphone Corporation has both the experience and facilities to advise you constructively on all problems connected with the recording of communications in the aviation field.

DICTAPHONE CORPORATION

INTERNATIONAL DEPARTMENT

420 Lexington Avenue, New York 17, N. Y.

The word DICTAPHONE is the registered trade-mark of Dictaphone Corporation, makers of Electronic dictating machines and other sound-recording and reproducing equipment bearing said trade-mark.

LES LABORATOIRES RADIOÉLECTRIQUES S. A.

ÉMETTEUR RÉCEPTEUR O.T.C. POUR L'AVIATION TYPE 214 L.C.

Caractéristiques

- GAMME 116.126 MC/s.
- Modulation d'amplitude.
- 10 canaux différents pilotés par quartz, utilisés dans la gamme par commutation des quartz. Pas de préréglage.
- Antenne fouet : 1/4 d'onde.
- Puissance porteuse : 4 Watts minim.
- Portée moyenne : 100 Km.
- Sensibilité récepteur : 10 μ V/m
- Nombre de tubes : 17.
- Puissance absorbée : 250 w (Source 24 V=)
- Poids total : 19 kg.

- Le poste type 214 L. C. dont la portée est d'environ 100 km à 500 m. d'altitude, permet d'assurer les liaisons avec les tours de contrôle et les goniomètres à ondes très courtes.
- La télécommande des fréquences et la mise en route se font par un commutateur à boîtier standard pour tableau de bord.
- Ce matériel permet l'utilisation en émission et réception de 3 autres gammes : 108.116 — 126.138 — 138. 152 MC/s. par simple changement des blocs H. F. amovibles et sans aucun réglage.

LES LABORATOIRES RADIOÉLECTRIQUES S. A.

SIÈGE SOCIAL : 14, AVENUE TRUDAINE - PARIS 9e

Tél. : Trudaine 17-64 et 65 - Adr. Teleg. LESLABOR

RATIER PROPELLERS

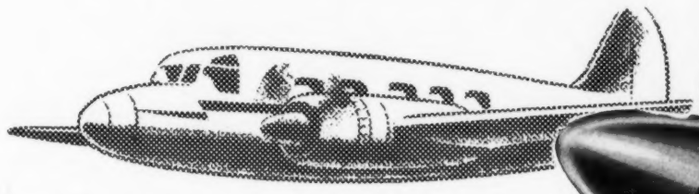
MONTROUGE
SEINE
CHATENAY
FIGEAC
ALGIERS
CASABLANCA
GENEVA

40 YEARS OF TECHNICS

LEONIDES

500 H.P. POWER PLANTS

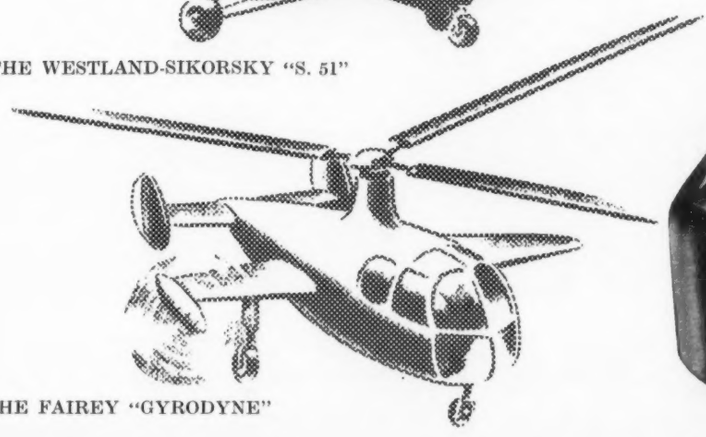
BRITAIN'S MOST MODERN RADIALS DESIGNED TO MEET THE FULL REQUIREMENTS OF A.R.B., M.O.S., and I.C.A.O. ARE IN PRODUCTION FOR SOME OF BRITAIN'S LATEST AIRCRAFT



THE CUNLIFFE-OWEN "CONCORDIA"

THE PERCIVAL "PRINCE"

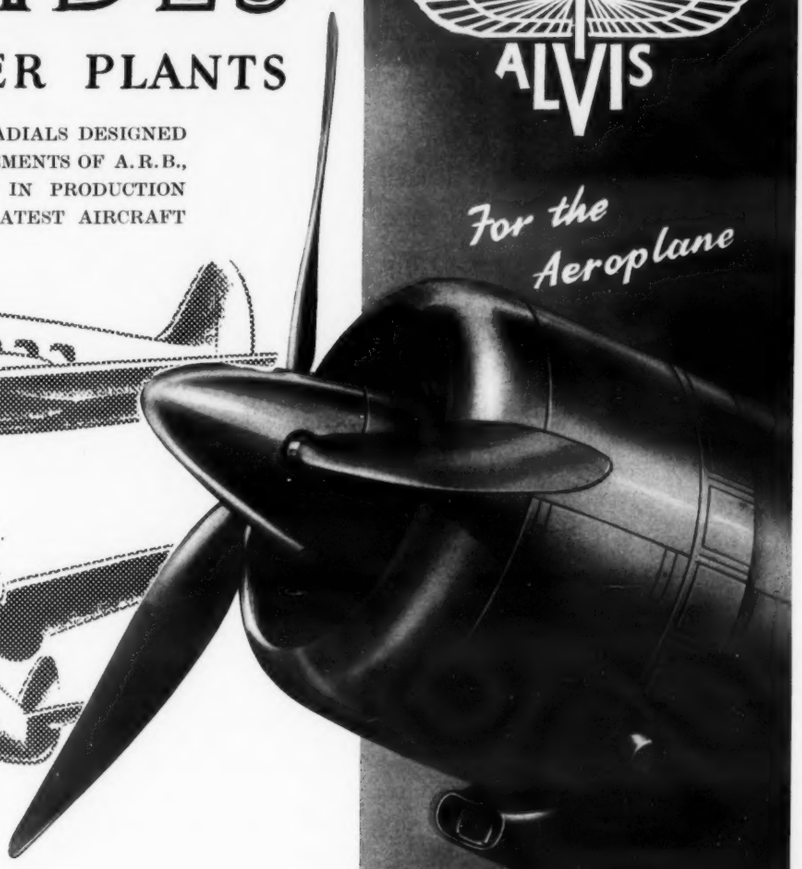
THE WESTLAND-SIKORSKY "S. 51"



THE FAIREY "GYRODYNE"

ALVIS

For the Aeroplane



For the Helicopter

ALVIS LIMITED • COVENTRY ENGLAND

MAKE SURE OF AN AGREEABLE TRIP

—CHOOSE

K·L·M

for your journeys throughout the world

There is hardly a country in Europe not served by the fine, new schedules of K. L. M.

Overseas airlines to : NORTH AMERICA
SOUTH AMERICA
WEST INDIES
NEAR AND FAR EAST

Regular services to : SOUTH AFRICA

SOCIÉTÉ

RATEAU

Sté Anonyme au Capital de 152.000.000 de francs

LA COURNEUVE (Seine)

SUCCURSALES ET AGENCES :
LILLE - NANCY - LYON - MARSEILLE
ALGER - BORDEAUX - NANTES - TUNIS
CASABLANCA - BRUXELLES
MUYSEN LES MALINES

OTHER SPECIALITIES
STEAM TURBINES AND GAS TURBINES FOR ALL PURPOSES
CENTRIFUGAL AND AXIAL PUMPS,
COMPRESSORS, BLOWERS
AND VENTILATORS
PISTON COMPRESSORS
INDUSTRIAL COCKS

GAS TURBINE ENGINES
TURBO-SUPERCHARGERS
SUBSONIC AND SUPERSONIC WIND TUNNELS
TEST BENCHES FOR PISTON AND JET ENGINES
AT VARYING ALTITUDES

Just as the Sun is indispensable if the flowers are to bloom.

...the "Norécrin" is indispensable if your business is to flourish

An aircraft for business, touring and public transportation

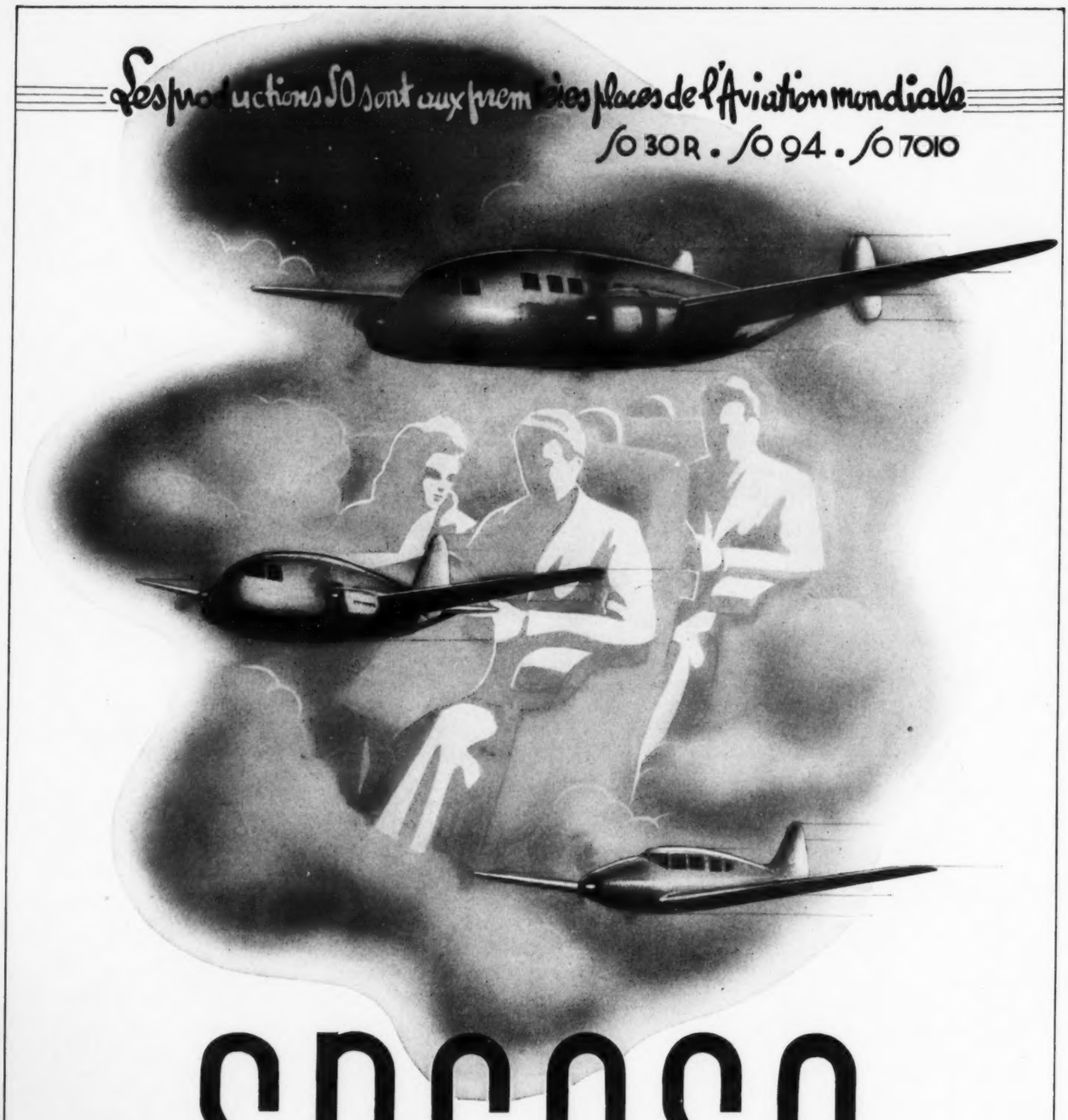
Three seats - 165 m. p. h. - 24 m. p. g. - 150 H.P. engine

The "Norécrin" is a product of the Société Nationale de Constructions Aéronautiques du Nord

20, rue Vernier PARIS 17e Telephone Galvani 94-52

Les productions SO sont aux premières places de l'Aviation mondiale

SO 30 R . SO 94 . SO 7010

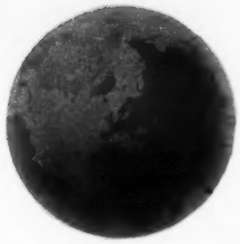


SNCASO

SIÈGE SOCIAL : 105 AVE R. POINCARÉ - PARIS XVIE - TÉL : KLÉ. 32-20

Dm

Marginal Notes



EAST WIND — WEST WIND

From the international angle, aviation has not been marked by any events of world-shaking significance during the hot month of July, 1947. A certain amount of planning and one or two projects executed : the UNO Security Council established a preliminary programme for the much-desired world police force of the United Nations, to which, for instance, Great Britain should contribute 1,275 aircraft and the U. S. A. 4,800, whilst the Soviet Union recommends equal contributions by the five Great Powers (Russia, U. S. A., Great Britain, France and China). Another trend which might be recorded is that more severe secrecy regulations have been applied to the official U. S. statistics on orders and deliveries of U. S. military aircraft. As regards international civil aviation, there has been an all-round need for more cash, which has manifested itself in the form of a capital increase for KLM Royal Dutch Airlines, financial losses for British Overseas Airways Corporation, and which may possibly lead to a merger between the State-controlled ABA and the privately-financed SILA in Sweden.

This is beside the point.

There has also been an all-round endeavour to make progress, not only in the technical field but also in the direction of culture, peace and international relations. And thus the International Air Transport Association, of Montreal, convened a preparatory conference of the world's major airline companies' public relations officers from July 22nd to 25th, 1947, in Prague.

This may not be an event of world-shaking significance either, but the choice of the meeting place, the agenda and the particular type of participants all point to certain things of which the future realisation may be of importance.

Sixteen international airline companies sent their representatives responsible for relations with the public, press and radio, to Prague : Pan American Airways, American Overseas Airlines and United Air Lines ; Panair do Brasil ; South African Airlines ; British Overseas Airways and British European Airways ; Air France, KLM, Swissair ; ABA, DDL, DNL and SAS ; the Polish LOT and naturally the host, the Czechoslovakian CSA. The following observers were present : a representative of the International Civil Aviation Organisation, of Montreal, and two Italian delegates, one representing the Anglo-Italian Alitalia and the other representing the Sardinian Airone, both being admitted as observers only, because Italy has not yet been authorised to be represented officially at ICAO and IATA meetings. Finally, the international aviation press was represented by three people : the President of the U. S. Aviation Writers Association, the Air Correspondent of the British Kemsley Newspaper Group, and the Publisher of Interavia, Geneva.

This was the first time a conference had been called for the express purpose of promoting the news services of the separate companies and their relations to the press and radio and thus to the wider sections of the public. It was a preparatory conference, which worked out certain recommendations that will be discussed again in the near future. And finally, it was a gathering which plainly bore the personal stamp of the IATA Director General, Sir William P. Hildred, and of the Association's Public Relations Officer, S. Ralph Cohen. Above all, it was a conference in Prague . . .

Why Prague ?

It so happens that no mention was made of international politics, but one could not help but sense its presence right behind the doors of the conference hall. Prague is today the bridge between the East and the West. Czechoslovakia is at present that Slav enclave which thrusts deeply into the European West, and in which the West and the East have to meet.

Visitors to Prague were welcomed by General Stanowsky, Director General of the Civil Aviation Department of the Czechoslovak Ministry of Communications. A further welcome was given by General Kubitha, Managing-Director of Ceskoslovenske Statni Aerolinie, the Czech national airline. The hospitality was over-generous, typical of the East and of the Slavs . . . The languages were of the East and the West, Czech and English. What more could one ask for ? Is not a meeting of this sort, however insignificant its outcome may be so far, symbolic of the goal for which a peace-loving world is striving ?

Are your fully aware of which airlines are already operating scheduled services to Prague ? Pan American Airways and the Russian Aeroflot ; British European Airways, the Russian-Jugoslav JAT, the Russian-Hungarian MASZOVLET, the Russian-Roumanian TARS and the Polish LOT ; Air France, KLM Royal Dutch Airlines, the Belgian SABENA, the Swedish ABA, the Danish DDL, the Norwegian DNL, and Swissair, and of course, the Czechslovakian CSA. Fifteen international airline companies !

Why do they all fly to Prague ? Prague is a bridge and a hope : the only bridge between the West and those regions which are ostensibly, or in reality, closed off by the Iron Curtain, symbol of the Russian hedgehog position which the Soviet Union finds itself forced to assume for reasons which do not belong here ; Prague is a hope because the West and the East have met there for centuries when it used to be the capital city of the Bohemian kings, and also because it is possible that new threads may be spun there tomorrow.

From the profuse printed information material which was handed to the foreign visitors, a few sentences are clearly symbolic of the firm attitude and intentions of Czechoslovakian politics :

Dr. Edouard Benes, President, on February 3rd, 1944 :

" Our State will carry out a number of economic and social changes and will adopt the principle of a 'planned' political and economic policy. " In effect, Czechoslovakian industry, commerce and banks have been nationalised, thus taking the middle way between the western and eastern conceptions.

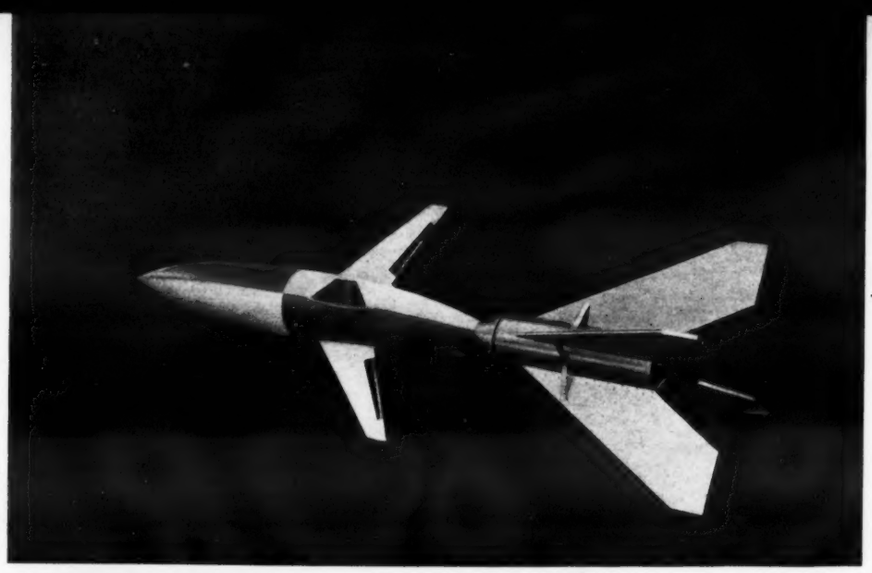
Prime Minister Gottwald, on August 8th, 1946 : " . . . it is possible for us to work out a Two-year Plan for the reconstruction of the Republic in the years 1947 and 1948 . . . increase in the production of capital and consumer goods above the pre-war level so that we may satisfy the relatively high standard of living of our people . . . "

Minister for Foreign Affairs Jan Masaryk, on March 20th, 1947 : " . . . Our relations with the Soviet Union as allies and friends have also opened up for us wide possibilities . . . In air transport Czechoslovakia has ratified the International Convention . . . the main task for the near future will be the establishing of regular air connections with the Near and Far East. A promising start was made by the conclusion of an air pact with Turkey . . . "

The situation is well worth our attention. Czechoslovakia has connections with Turkey, and even with the Soviet Union. Perhaps by 1948 she will be flying air services to Iran, and even to America. Before long, Czechoslovakia may no longer be a mere point of intersection, but a veritable crossroads, an exchange terminal for goods and thoughts between the West and the East. On the other hand, if this does not take place it would be ominous for the East, the West, and Czechoslovakia herself.

One could ask whether it was not for one of these reasons that Prague was chosen as meeting place for the IATA Conference. Whilst conducting a sight-seeing tour of the city, our imaginative guide compared Prague with Rome . . . The Hradschin is not the Capitol, the Moldava is not the Tiber, the hills around Prague are not the " Seven Hills, " and the Czechs are no Romans . . . But it used to be said that all roads lead to Rome—perhaps they may lead to Prague tomorrow.

EEH.



Bombers and Space Weapons

Since the cessation of the last great war, the world has experienced two years of peace ; two years crowned by atomic bombs and V2 robot missiles ; two years of peace which have been singularly reminiscent of the " phoney war " from 1939 to 1940.

V2, Hiroshima, Nagasaki and Bikini are names associated with a war of nerves which is only in its infancy. To satisfy the public's lust for sensation, the world's newspapers have fed their readers on accounts and prophecies of a forthcoming war in the air, with the commander-in-chief seated before a lavish array of levers and switches in a control station deep under the ground, steering gigantic space weapons with atomic charges halfway across the world by a mere pressure of the finger, and listening to a loudspeaker's reports of great cities wiped off the face of the earth.

Secrecy regulations and cunningly-sown rumours from all camps have given rise to precisely what they set out to do. Today, the world believes that all major countries are in possession of such weapons, and that these only require slight final improvement before they are ready for operation.

Would it not be interesting to examine this state of readiness a little closer, to find out how far research and development have progressed towards practical application of the still very young sciences of modern jet propulsion and supersonic aerodynamics ?

Despite mystifying rumours to the contrary, present experience and knowledge of remote-controlled, unmanned missiles is not sufficiently advanced to justify a complete revolution in aerial warfare strategy and tactics for at least another ten years. It is doubtless that all countries engaged in research on unmanned missiles aim to make these travel at supersonic speeds, for experience in the case of the V1 showed that a projectile of less velocity can easily be fought and rendered harmless. And as for manned projectiles, it was seen from the example of the Japanese suicide weapons that such engines cannot pierce a modern A. A. barrage of proximity-fuse shells.

Which then are the aerial warfare weapons of the future ? Today, every country is fostering, regardless of expense, the development of two arms : *Supersonic Aeroplanes* designed to do the job of our present fighter and bomber aircraft, and *Rocket Missiles*. For the latter, distinction should be made between two fundamentally different constructions : *space weapons after the pattern of the V2* *, destined to replace long-distance artillery and bombing from the air as soon as the remote-control technique has been perfected. Fired from the ground, these space weapons are to travel at several times the speed of sound and also to attain the target at supersonic speed. In principle, they bear only a very slight resemblance to present-day conventional aircraft, and are designed almost solely in accordance

* Cf. "INTERAVIA REVUE" No. 5, May, 1947, P. 27—32 and No. 6, June, 1947, P. 33—37.

Admiral O. C. Badger at the Navy's Point Mugu test centre, controlling a radio-controlled "Bat" glide-bomb ; successfully operated during the last months of the war, the "Bat" is one of the few efficient unmanned missiles ready for action.

with our knowledge of supersonic ballistics and the exigencies of supersonic aerodynamics. As soon as further progress in the domains of jet propulsion, mechanical guidance and radio control permit the operation of such missiles, then the time will have come for the bomber aircraft to drop out of the game. But a long road has still to be travelled before that occurs.

Such a weapon is of military value only if it can attain its target with dead accuracy. This does not yet apply to the space weapon, so that the heavy bomber must remain the most effective means of defence for some years to come. For this reason, research is going on in all countries, regardless of cost, to find an efficient means of defence against attacking aircraft. There is no doubt that the solution lies in the robot missile, notably the type which is launched from a mother aircraft instead of from the ground. Missiles of this sort usually have a relatively small range of action, not much more than 15 miles, and are powered by engines of low output. Apart from pure rockets, such as those fired from aircraft towards the end of the last war, the main interest is centred on the various types of *flying bomb* which, equipped with remote control, are guided towards the target from the mother aircraft, usually without exceeding the target aircraft's speed in any great measure.

Flying bombs were under development during the last war, and were experimentally put into operation—though without any great success against aeroplanes. Insufficient range and speed, inefficient remote control, exposure of the mother aircraft to attacks by enemy escort fighters, and many other factors caused the operation of flying bombs to be directed chiefly against such moving surface targets as ships, railway trains, and so on.

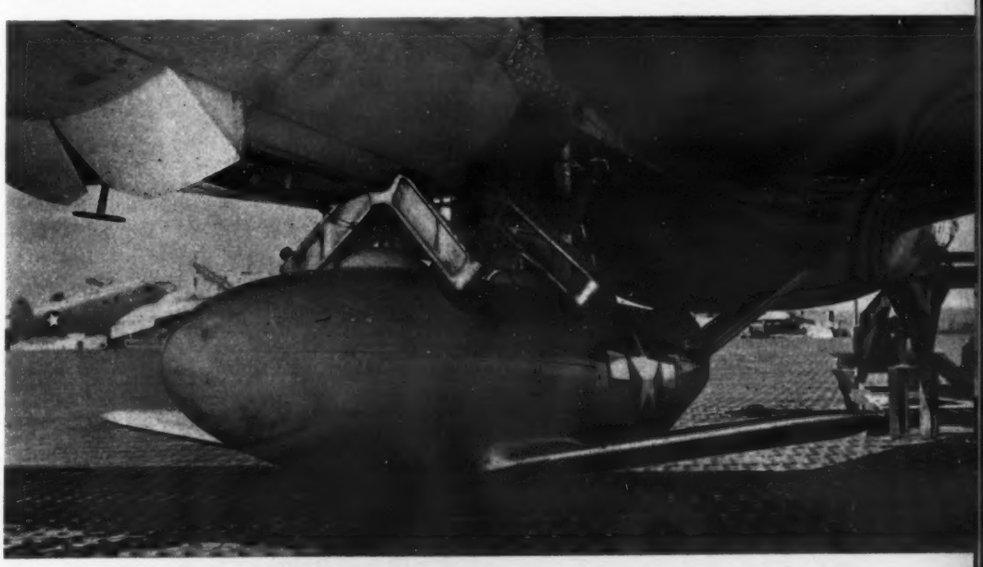
Students of aerial warfare have rather more confidence in the future of aircraft-type *flak projectiles*, which are fired from the ground by rocket means and, guided by radio, attain sonic or supersonic speeds. As, for logical reasons, indirect allusion only is made to these promising constructions, and only pictures of far less offensive and already obsolete flying bombs are available, the following paragraphs contain a brief description of a missile that could be regarded as a pattern for all such aircraft type missiles, and which was subjected to its first supersonic flight tests during the last months of the war.

This is the "Wasserfall" (waterfall), a flak rocket under development in 1945 in Germany, designed for operation against aircraft flying at altitudes of two to ten miles and distances of thirty to forty-five miles from the launching site. The "Wasserfall" project was begun in 1942 and required intense efforts on the part of a large staff of scientists until the missile could fulfil what was expected of it. To begin with, the designers had to

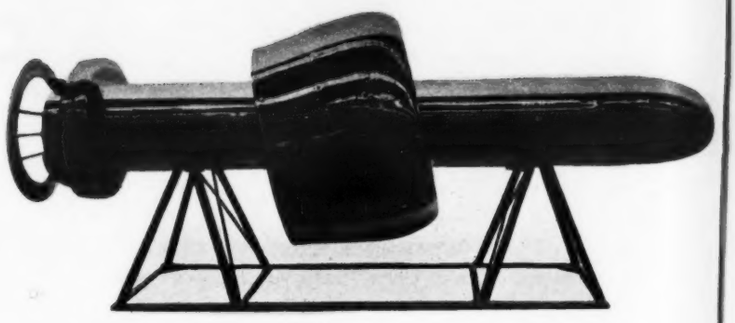
A Grumman TBM carrier-borne fighter carrying radio equipment beneath the fuselage for guiding unmanned missiles; the TBM also has complete radar search equipment for controlling shipping operations within a radius of 150 miles.

One of the many experimental missiles used in the U. S. A. for testing radio equipment and jet engines. The canard-type "Gorgon" carries a radio set in the nose and is powered by a rocket motor. Another version of the "Gorgon" was experimentally fitted with a ramjet.

"Gargoyle," high-speed winged bomb for ground targets; built like an aeroplane, it travels at about 600 m.p.h.



"Gorgon IIIA," another jet-propelled winged bomb of the U. S. Navy.



The television-controlled "ROC" jet bomb is one of the few U. S. constructions with an annular supporting surface.

come to an agreement on the method by which the projectile should follow the target. For certain reasons, the conventional A. A. gunnery method with an angle of lead could not be employed. As will be recalled, this method is based on the assumption that the target will continue to fly at the same speed, altitude and in the same direction as in the moment the A. A. gun is fired, so that the paths of the target and projectile will cross when both are in the point of intersection. If fired in a vertical position, the projectile needs to make a substantial change in direction at the beginning only, whilst for the subsequent section of the trajectory, its homing device enables it easily to keep to the prescribed angle of lead. Of course, it is a different matter if the target chooses to change its direction. Then, for the projectile to keep on the target's track, it would have to effect changes of direction which, in view of the long lever arm of the lead, can assume unbearably high values. If such trajectory curvatures are required shortly after the take-off, while the projectile is still carrying a full load of fuel, then the lift values that would be necessary cannot be attained at the low initial speed because of the small wings fitted to supersonic missiles. We need not go into the reasons for which an enlargement of the wings is inadvisable.

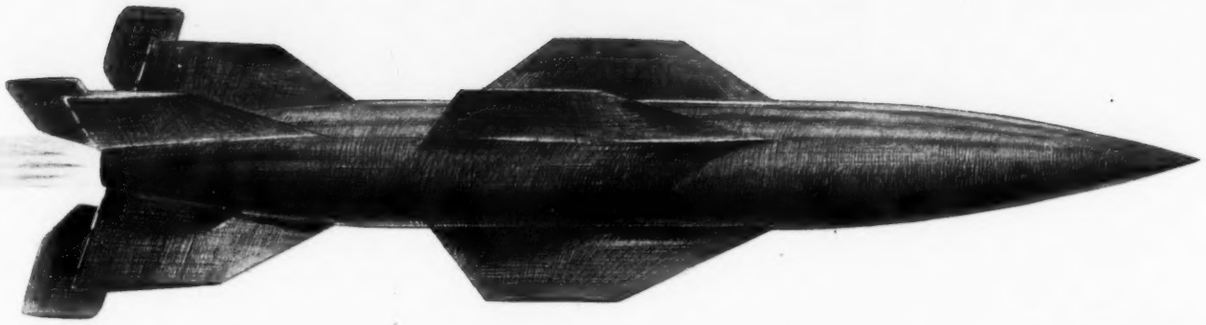
The " Wasserfall " was therefore controlled according to the so-called three-point system, which is also the principle incorporated in the latest U. S. flak rockets. This system requires that the firing point, missile and target constantly lie along a straight line. Hence, the initial trajectory curvatures are very small, even if the target executes large evasive movements, and they do not assume greater proportions until the target is almost attained. At this moment the speed is already so high that the small wings are perfectly capable of producing the high amount of lift required. Moreover, the weight of the projectile has greatly decreased by this time, due to the consumption of the fuel, so that the centrifugal forces also remain within suitable strength limits.

The main difficulty in designing the " Wasserfall "—once the control by means of the " Würzburg " radar device had been solved, at least in principle—was to build a missile which could be guided in all directions, of which the control would remain effective over a very wide velocity range, and of which the stability characteristics would remain unchanged during the piercing of the sonic barrier. It was only after a thorough investigation of the most varied forms and positions of supporting surfaces (among others, a model with an annular supporting surface was tried out) that a construction resulted in which the centre of pressure, thanks to an ingenious utilisation of the differing aerodynamic behaviours of fuselage, empennage and supporting surfaces, remained unchanged throughout the entire velocity range. For the last miles of the trajectory a homing device was to take over control of the " Wasserfall, " leading it towards the target until the proximity fuse could begin to function.

The fact that the U. S. A., which is giving shelter to a great number of German scientists, is making use of this war experience, is logical. Meanwhile, however, only scanty data are available on the development of flak projectiles of the " Wasserfall " type. From the details so far released on flying bombs, we may infer that in the United States, no great military importance is being attached to this type of aerial warfare weapon—at least, not in its present form. For the present it seems that all these constructions are being used primarily for proving remote-control devices and partly for testing jet engines.

U. S. military experts are earnestly engaged on the problem of *large-size rockets,* as is evident from the current firing tests of captured V_2's and a few U. S. constructions ; all are being used chiefly for research purposes. A whole series of important aeroplane and engine manufacturers, such as Douglas, Boeing, North American, Bell, Consolidated Vultee, Northrop, General Electric, Westinghouse, Aerojet, Reaction Motors, etc., are participating in the research programme. The first space rocket which could be written about in the U. S. A. was the *WAC " Corporal, "* developed

Radio remote-control set in the missile's nose.



German "Waaserfall," supersonic flak projectile which did not reach the operational stage during the war, but today forms the pattern for remote-controlled A.A. defence projectiles.

on the West Coast by the California Institute of Technology (cf. " INTERAVIA REVIEW" No. 3, June, 1946). Weighing about 150 lbs. gross, it was followed up by a further experimental model, the " Corporal E, " weighing about ten times as much, which was fitted with remote control and first launched last spring from the Army's White Sands proving ground in New Mexico.

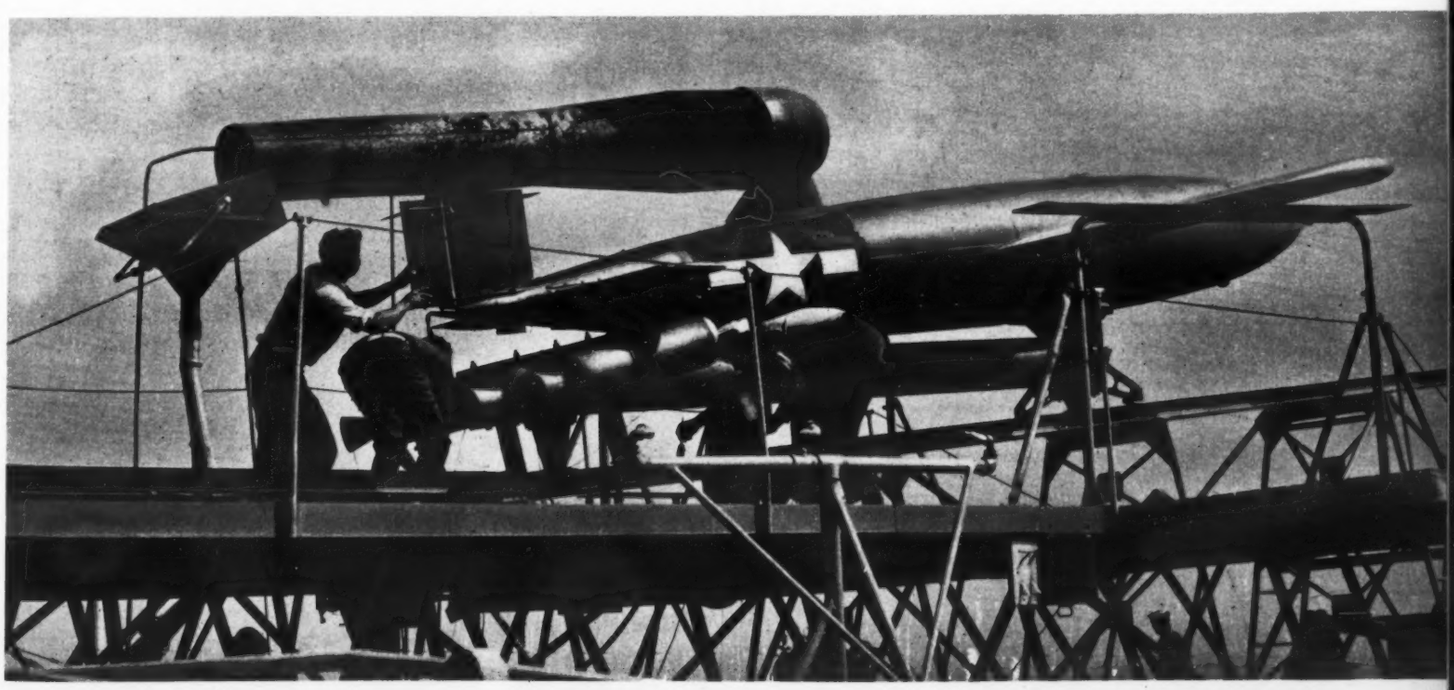
Whereas the " Corporal " attained an altitude of about 45 miles, a new experimental rocket project, the " *Neptune*, " built by *The Glenn L. Martin Co.*, is expected to reach a height of nearly 240 miles. It will be remembered that the V2 could climb to around 110 miles, carrying a maximum payload of 2,600 lbs. It is intended that the " Neptune " should carry loads ranging from 100 to 2,000 lbs. and that these varying loads should have no perceptible effect on flight behaviour and stability. This gives rise to a new problem which the engineers expect to solve by means of automatic gyro stabilisers and reorientation of the line of thrust. Fuel will be alcohol and liquid oxygen and the engine is being constructed by Reaction Motors, Inc., Dover, N. J., makers of the rocket engine in the Bell XS-1 experimental supersonic aeroplane. The " Neptune " engine is being built to produce 20,000 lbs. of thrust over a period of 75 seconds. Whereas the XS-1 engine relies upon compressed nitrogen to feed the fuel, the " Neptune " engine will employ a method which was used in the V2. A pressurising system using helium at pressures of 3,500 lb./sq. in. will assure adequate flow of all fluids, feeding highly concentrated hydrogen peroxide (H_2O_2) into a gas generator for decomposition on contact with a manganese compound, with the resulting steam driving the turbine. Simultaneously, the product of decomposition will be employed to correct rocket roll. The weights of the propellants are : alcohol, 3,380 lbs ; liquid oxygen, 3,760 lbs. ; hydrogen peroxide, 270 lbs. ; helium, 8 lbs. Measuring 45 ft. 3 in. in length and 32 in. in diameter, the " Neptune " will feature a gross weight of 9,510 to 11,410 lbs., according to payload, and is expected to attain a maximum speed of 8,200 ft./sec.

A small-size model may be ready for testing within the next few weeks, but the first firing of the final " Neptune " is planned for June 1948. The Glenn L. Martin Co., which is working on the project under contract to the U. S. Navy, has an order for ten units, all of which are for pure research purposes.

From all these efforts to acquire precise data on the problems of supersonic flight, whether for the development of aircraft or space weapons, it is clearly evident that the main military demand is for speed. In the last war there was only one weapon against which no direct means of defence existed, namely, the supersonic V2.

Though warfare tactics do not require that the final speed of such missiles be extraordinarily high—one and a half to two times the speed of sound should be sufficient—the most important problem of the day still remains to be solved, that of *propulsion*. Solid fuels for rockets are being abandoned more

Intensive tests are being carried out in the U. S. A. with captured German V1 "Doodlebugs." The photo shows a V1 fitted with assist-take-off rockets, ready to be fired from a ramp destined for equipping battleships and submarines.



A V2 on its way through the New Mexico desert to the launching site at White Sands.

The launching site at White Sands. At left is an observation tower and the block-house ; centre, the gantry crane which surrounds the V2 while it is being prepared for launching ; and at right, another rocket firing position.

and more, and chemists are endeavouring to replace operationally dangerous alcohol-oxygen mixtures by handier substances. In view of their simplicity, however, solid fuels may still be used for small missiles, despite the unfavourable ratio between their weight and that of the combustion chamber, which is mostly around 1 : 4 and only seldom as low as 1 : 2. Apart from this, such fuels have also proved to be extremely useful for assisted take-offs.

Liquid fuels require considerably lighter *rocket engines,* of weights in the order of 1 per cent of the thrust. Comparison with the best pure jet engine (approx. 40 per cent) shows the advantages of such constructions which, though they are relatively unfavourable at low speeds, all the same feature degrees of thermal efficiency that are superior to those of stationary power plants. Seeing that it does not need to draw oxygen from the surrounding air, the pure rocket engine will probably be used at flight altitudes of 100,000 feet and above, at speeds of over 3,000 m. p. h.

For slightly lower speeds, in the 1,000-2,000 m. p. h. range, another means of propulsion produces better results. This is the *ramjet* which, still in the experimental stage, is extremely simple in structure, consisting of an inlet diffuser, combustion chamber, and jet pipe. According to the press, a power unit of this type has already been subjected to successful supersonic flight tests in America : Johns Hopkins University is developing the " Bumblebee, " a ramjet A. A. missile which is accelerated by means of take-off rockets until sufficient speed has been reached for the power plant to start functioning. The VI involved an interesting application of the ramjet principle : equipped with valves for periodically interrupting the air entry and combustion, pressure conditions could be created to allow propulsion to continue at subsonic speeds.

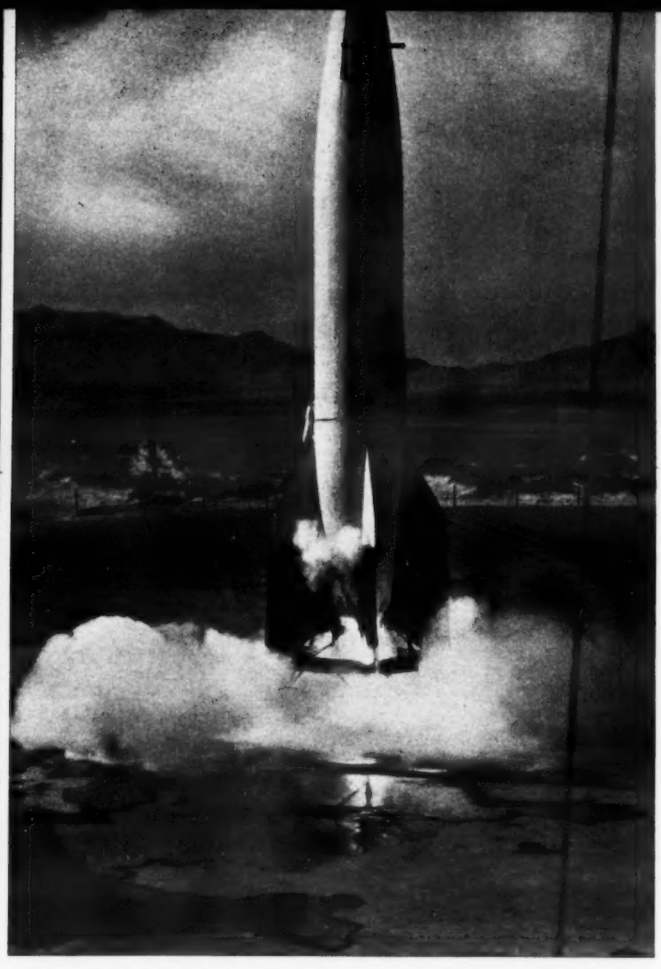
Below the best efficiency range of the ramjet, thus for the upper subsonic region and the sonic barrier itself, the *pure jet engine* promises to yield better results, and today powers all the latest fighter and bomber aircraft. In certain cases it is possible that it may be combined with the ramjet, producing an arrangement similar to the post-combustion chamber for thrust increase built in San Diego by Ryan Aeronautical Co.

The problem of remote-control still remains to be solved. Admittedly, it was possible at the end of the war to make an aeroplane and even squadrons take off by means of radio signals, send them on an observation mission and have them land again. The tests in Bikini proved this. But until a system of remote-control has been acquired which can guide an aircraft or a missile over a wide speed range until it attains the supersonic region, with sufficient accuracy to fulfil military requirements, whether for the destruction of a target in the air or a pin-point ground target from a great distance, a long road has still to be covered. Moreover, radar technique as it stands today will only be of use for short-range operations, for instance flak projectiles. But for radar equipment too, as can be inferred from the above description of the " Wasser-fall, " there will have to be a division of the control into two more or less independent systems : remote control of the missile from the ground until target proximity, and homing as soon as the equipment for this purpose is near enough to the target to start functioning. As radar rays are limited to optical range, the conditions for space weapons are con-

Beneath nearly 30 feet of concrete, civilian and Army technicians and German rocket specialists take their posts at firing stations a few minutes before launching.

View at base of V2, showing part of fuelling procedure.

The V2 is aligned on the launching platform until it points exactly 90 degrees from the earth's surface.



The fuel has been ignited and before long the V2 will shoot skywards.

siderably more involved and may still require long and tedious research work before perfection.

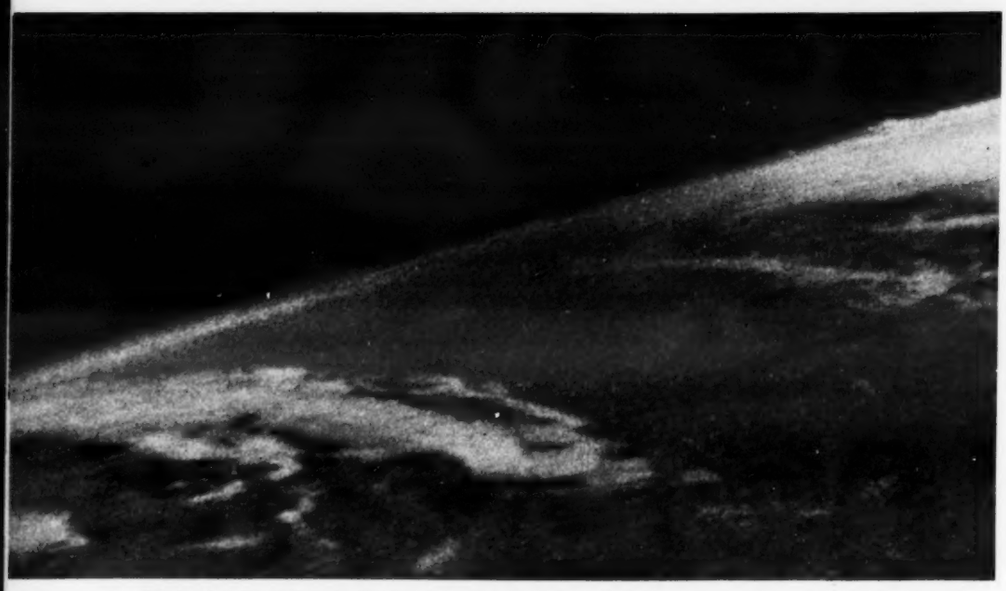
We only need to take a look at our present supersonic wind tunnels, which usually have very restricted working sections and as a rule do not exceed Mach Numbers of 2, to realise that the means at our disposal are still insufficient to meet the demands of a theoretical research programme into supersonic aerodynamics. The American WAC "Corporal" experimental rocket already attained four times the speed of sound and the German V2 exceeded Mach Numbers of 5.

Already during the course of the last war the taxpayer had the right to be indignant about the enormous sums which every airfaring country was spending on the creation and maintenance of a powerful air force. But all these expenses, high as they made have seemed at that time, appear puny beside the sums which are at present necessary for research and development of new aerial warfare equipment. Not every country allows its nationals to see what is going on in this connection. It is therefore interesting to take a look at the projects and expenditures which are currently being planned in the U. S. A., but which Congress still has to consider.

There are already a good number of test and development centres in the U. S. A. for aeroplanes and missiles. Apart from *Wright Field* and *Patterson Field*, which are the best known and form the headquarters of the Air Materiel Command, perhaps the most worthy of mention are the facilties

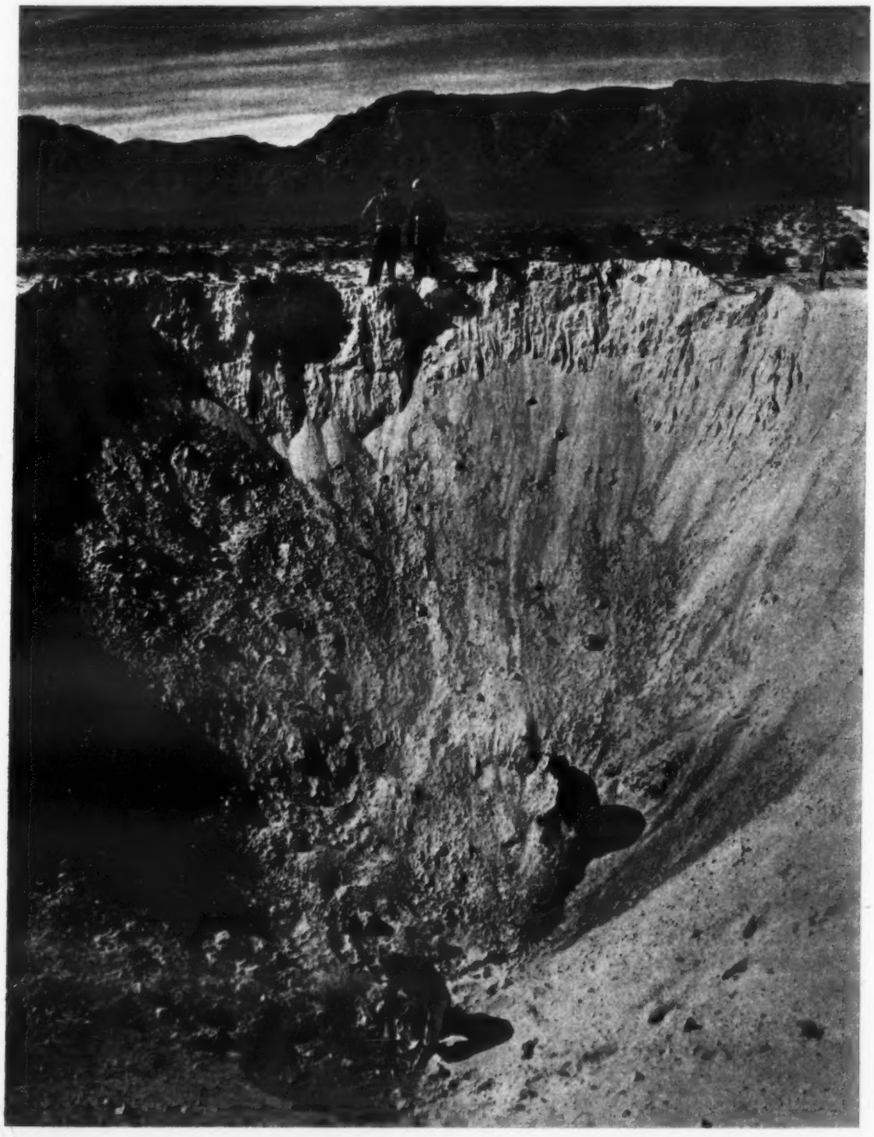
Clouds of dust obscure the launching site, while the V2 rapidly ascends.

Gathering speed, the V2 heads for the ionosphere.



This is what the earth looks like from 65 miles altitude ! Photographed from a V2.

No explosive is contained in the warhead of the test V2's fired at White Sands, but this huge crater testifies to the force with which the missile strikes the desert floor. The explosive effect is partly due to the bursting of the fuel tank which could still have contained a small remainder.



at *White Sands* and at *Almagordo*, some forty-odd miles away, where the A. A. F. is erecting new firing blockhouses and setting up instrumentation. The Navy controls the test station at *Inyokern*, where rocket motors and various types of missile are developed and tested ; subsequent large scale Naval tests are carried out at *Point Mugu* on the Pacific coast. Then, another missile centre, situated on the Atlantic coast at *Chincoteague*, is primarily for the development and testing of bomb and gun sights, and missile guidance and seeking devices, and is also operated by the Navy. Moreover, the Government's National Advisory Committee for Aeronautics (NACA) is planning to enlarge its laboratories and is seeking credits amounting to $ 43,500,000 for research on new air war weapons ; and the *Cleveland*, *Langley* and *Ames* laboratories, also national institutions, want about $ 10,000,000 for building new supersonic wind tunnels and developing existing facilities.

Meanwhile, the two biggest projects at present being considered in the U. S. A. will require far higher sums. One of these is a *long-range missile test centre* where tests can be conducted over hundreds or perhaps thousands of miles. The other is a gigantic national institution to be known as the *Air Engineering Development Center*, which may possibly bring about unification of the present uncoordinated work carried out by the Navy and Army. Apart from a supersonic wind tunnel of incredible dimensions—reference is made to a power of 1,000,000 H. P. —it is to receive a wind tunnel with a throat measuring 40 × 40 ft, capable of creating wind speeds of up to Mach Number 1. Building costs : one hundred million dollars—requested for both projects : five hundred million dollars.

At the end of World War I only few people realised that the bomber was the weapon of the future. Though at that time it did not play a decisive part in shaping the outcome of the war, it did manage to accomplish important tasks. We were well aware of its strategic value in 1939, but it was not until 1943 that the decisive operation of long-range heavy bombers took place.

The end of the last war was marked by the operation of guided missiles. The possibilities of these weapons are almost unlimited—but their development still calls for many man-years. There will be no repetition of bomber aircraft history, where over twenty years were necessary before the goal was reached. Space weapons will be reality within the next five years ; but until their range and precision is such that they can forge the destiny of a war across oceans, at least the same period of time will elapse. *Bi.*

Flight to the Antilles

By Georges Février, Paris

Landplane or flying-boat ? The argument is never-ending, and will continue as long as there is such a thing as aviation.

It is therefore not my intention to lend support to either one party or the other in this eternal controversy, but to relate certain facts as I experienced them personally. Not very long ago I had the good fortune to participate in the inaugural flight of Air France's scheduled service from Paris to the Antilles—on board a Latécoère 631-03, a flying-boat.

You may recall that the Latécoère weighs about 72 tons and is equipped with six Wright engines of 1,600 H. P. each. She is probably one of the first large flying-boats to have been fitted with retractable lateral floats ; during flight they bury themselves in the outboard engine nacelles.

I had previously had a chance to appreciate the comfort, "sturdiness" and, above all, the flight characteristics of the Latécoère 631 on the occasion of a trip from France to South America—the fateful trip on which the aircraft came to grief about one hundred miles north-east of Montevideo. You may remember the circumstances.

As a result of a breakage in the propeller hub of the port inboard engine, a propeller blade ripped off and sliced into the fuselage at a point about eight feet high. Completely out of balance, the engine broke loose from its mounting and smashed one of the propeller blades of the centre engine, causing the entire nacelle to hang precariously from the wing, with the propeller windmilling madly. To top it all, the first broken blade managed to cut out through the servo-system controls.

Despite this critical state of affairs—and with 64 passengers on board—the pilot, Jean Moulignié, kept his machine in a normal attitude and executed a perfect emergency landing in the lagoon of La Rocha, Uruguay. Four days later the plane took off again on its own power—four engines only. Unfortunately, the blade penetrating into the fuselage had caused the death of two passengers.

However, the aircraft had proved that it possessed exceptionally-good, perhaps unique, flight characteristics. You may recall that there is a manhole in the wing, providing access to all six engines during flight. With one engine stopped, the range is 1,860 miles ; a gross weight of 60 tons is possible on four engines only, and 50 tons on three engines.

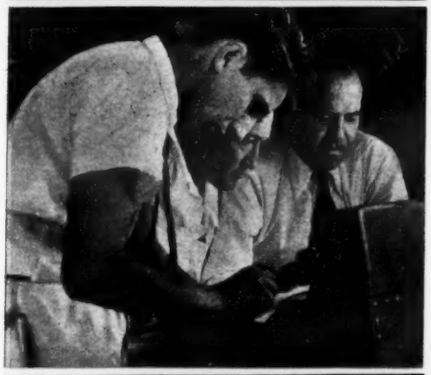
Incidentally, I would like you to remember that the Latécoère 631 was designed in 1937. The man responsible for it is the well-known specialist on heavy flying-boats, Marcel Moine, who was at that time chief engineer of the Société Latécoère.

A Few Statistics.

The France—Antilles route is flown in two legs : Biscarosse (near Arcachon)—Port Etienne (Mauretania), in all 1,985 miles, counting the detour around Spanish territory ; and Port Etienne—Fort de France (Martinique), a distance of 2,940 miles, entirely over water.

It should be pointed out that the latter section is the longest non-stop route flown in the world (the San Francisco—Hawaii stretch is only 2,425 miles) and that, both for the outward and homeward trips

Leclaire, Air France's crack flying-boat pilot, captained the F-BANU on its first flight to the Antilles.



René Lefèvre, Air France's expert on trans-ocean operations, at the navigator's table.

Monsieur le Député Servos is keenly interested in the flight engineer's job.

Morvan, operations chief, is visible in the background, near to the radio operators.

"Receiving you loud and clear..."

Navigator Roux and Commandant Leclaire.

The steward at work : at your table in ten minutes.

Lunch on board : Max Hymans, Director-General of French Civil Aviation, and René Lefèvre.

Bon appetit !

The writer tries his hand at the controls of the F-BANU.

The Latécoère 631-03 casts its shadow on the desert.

About to land at Port Etienne.

on the inaugural flight, there were 58 people on board, 46 of whom had berths. On long trips of this kind, comfort must be borne in mind as well as security ; and at the present moment the comfort on board the Latécoère 631 is truly unique.

But before going into all this, I would rather give you the figures.

The take-off from Biscarosse was in the early hours of Saturday, July 5th, 1947, at 3.15 G. M. T., with the flying-boat weighing about 67 tons gross. The landing at Port Etienne was made ten hours and forty minutes later, at 13.55 G. M. T., the 9,185 miles, including take-off and landing, having been covered at an average speed of 190 m. p. h.

Fuelling at Port Etienne lasted four hours, as this station has not yet been equipped with bowsers. We took off again at 18.37 G. M. T., this time with a gross weight of 157,630 lbs. as we were carrying 6,225 Imp. galls. of fuel. The speed of the wind was 25 m. p. h. and the take-off was effected in 41 seconds.

After night had fallen (20.07 G. M. T.) we encountered very heavy cloud formations, which is a rare occurence on this fine-weather route. But our ship was sturdy enough, and the most we felt was a very slow and slight heaving motion. On Sunday, July 6th, at 10.12 G. M. T., after having circled around Fort de France for about 25 minutes, our aircraft landed. It was exactly 15 hours and 35 minutes since we left Port Etienne, which meant that the 2,940 miles had been covered at an average speed of about 188 m. p. h.

There were still 1,320 gallons in the tanks, which would have sufficed for a further 6 hours 40 minutes flying at an economical cruising speed of 155 m. p. h. This would also have permitted eventual alternative landings to be made, at Trinidad for instance.

In conclusion, I would like to give you a few data on the return trip : Take-off from Fort de France on Wednesday, July 9th at 14.13 G. M. T. with 6,865 gallons of fuel, requiring one minute at a gross weight of 158, 290 lbs. ; arrival at Port Etienne on Thursday, July 10th, at 7.28 G. M. T., take-off at 10.53 and night-landing in Biscarosse the same day at 21.21 G. M. T. Duration of the outward trip (4,925 miles) including landing and take-off, 30 hours 57 minutes ; return trip, including landings and take-off, 31 hours 8 minutes. Prevailing winds were in the east-to-west direction.

Passengers were able to spend three days in Martinique, fly nearly 10,000 miles, and only be absent from France for 138 hours. And one point I would like to stress in particular : they all felt as fresh as if they had just got out of bed.

Well, now that I have given you the necessary facts and figures, I would like to give you an idea of the comfort provided on board. For this purpose I am asking you to imagine that you are making the trip with me.

The Flying Liner.

First of all let us go to the Air France office and choose our cabin. By the way, when I say cabin, I mean *cabin*. You must realise that we are not going to travel on an ordinary aeroplane where you merely choose any seat that happens to be free, but on a veritable "flying liner" ; the expression "flying-boat" is really too inadequate. Just like on an ocean-liner, you will find cabins for two or four people, with beds and running water ; then, a dining room and bar, a kitchen fitted with electric stoves and refrigerators, several separate toilets and, last but not least, a promenade deck leading from the extreme nose to the steward's quarters in the rear of the aircraft, where you have about twenty yards in which to take a constitutional.

Single fare from Paris to Fort de France is 65,000 francs, and the round trip ticket costs 117,000 francs. We climb on board the train at the Gare d'Austerlitz and upon reaching Bordeaux, go by bus to Biscarosse, just south of Arcachon. Incidentally, it will not be long before a flying-boat base has been built at Le Havre. Then we shall have a quick connection by Micheline, requiring only two hours, with all the customs formalities taking place on board the train.

The aircraft is anchored in its dock, and the luggage is already being loaded aboard. Passengers walking calmly along the gangway cannot help but admire the gleaming duraluminium panels of this magnificent machine which is to be their home for quite a number of hours. As we go aboard the chief steward gives us a cheerful greeting :

"Numbers 35 and 36 ? You'll find them on the left as you go towards the bar."

Here is our cabin, closed off by a curtain. Let's open it up. The armchairs, covered in red leather, have already been transformed into two berths, one above the other ; and the sky-blue bedsheets seem to invite us to hurry up. The cabin is luxuriously panelled and the floor is covered with a thick carpet. The washbowl can be folded up to form a night-table, replacing the large cabin table used for meals.

Here come the stewards with our luggage. Let us settle down . . . But the F-BANU is already gliding over the silvery water of the harbour, dotted here and there with red-illuminated buoys. The engines are revved up and we are soon climbing smoothly into the darkness. We are flying, but in the night the great ship seems to be absolutely standing still ; and if it were not for the throbbing of the six engines—which does not hinder normal conversation in any way—we could imagine ourselves as being in a small, cosy room on terra firma.

It may be late, but we have no intention of going to bed without a nightcap. In the bar, however, we find that at least twenty of our fellow-travellers have stumbled upon the same bright idea. At one table we hear the call of "four spades" ; at another someone is proudly revealing a "full house." Some people seem to be ready to spend the night over the green tables, but we feel rather more attracted by the blue sheets back in the cabin.

Whisky ? Champagne, or . . . Vichy water ? Let us order something quickly and turn in.

I can remember slipping in between the sheets, switching on the bedside lamp, reaching over for a book and . . . falling asleep. It is soon morning again, for it was rather late when we started the trip. As I glance through the window I see that the F-BANU has already left the Portuguese coast and is heading for Port Etienne.

I wash, shave—grumbling a bit because there is no hot water—and go along to the bar for a morning cup of coffee.

Our plane continues its journey, and if it were not for the shadow on the smooth surface of the ocean, we could not believe that we are travelling at 200 m. p. h. The time is spent in chatting, reading, lounging around the bar—in fact, life is just like on board a luxury ocean-liner. Before we know it, it is time for lunch, and we have to decide whether we want to eat in the cabin, or in the dining room where fifteen people are served at a time. Let's stay in our cabin . . . The steward brings us dish after dish : hors-d'œuvre, lobster mayonnaise, chicken in aspic and haricots verts, salad, fruit ; all these gastronomic delights are interspersed with excellent vintages of white and red Bordeaux, and finished off with coffee, liqueurs, cigars, cigarettes. — There are indeed worse ways of travelling.

Land is soon in sight again. Through the large, round windows we can see the golden sands of the desert, seemingly rolling out beneath us. The small settlement below is Villa Cisneros, and a little further ahead is Port Etienne.

Without our having noticed it, the plane has been losing altitude during the past few minutes. The lateral floats are being lowered, the flaps are down and the F-BANU is cleaving its way through the ocean.

Fast motor boats are already waiting to take us to land. Picturesque Moors, wearing blue turbans, help the passengers to alight. We have four hours before us.

Desert Excursion.

The sharp, sand-laden wind stings our eyes and faces. The Air France administration building looks extremely inviting, but we don't want to miss having a look around the "village." This forsaken corner

Coming in over the roof-tops of Port Etienne.

Port Etienne : the F-BANU is saluted by a Bréguet 731. .

Port Etienne is by no means the last word in luxury.

Even camels fail to get fat.

Fuelling before crossing the ocean.

Arrival at Fort de France, Martinique : our flying-boat is being taken in tow

Passengers alighting.

A great welcome.

The Air France colony on Martinique.

"Enchantée de faire votre connaissance..."

Fort de France : the fishing harbour.

Spending the evening on the beach.

Palm trees, tropical creepers, mosquitoes : only 26 hours' flight from Marseilles.

of the earth, where it has not rained since 1932, cannot manage to give life to a single blade of grass. There is not a drop of water to be had. Water has to be fetched from Bordeaux, Marseilles or Le Havre ; and as it costs some 16 sous a litre, it is far too expensive for the Moors to use it for any other but strictly internal purposes. The only tree in Port Etienne is at the military outpost. It has to be protected from the sun by a parasol and has not grown any higher for the last four years. Here and there stand huts built of flattened-out oil drums, where the Moors pass a few months a year of their miserable lives, the remaining months being spent on the arid desert wastes. Pretty native women squat meditatively on the sand, surrounded by hordes of naked, yelling children and herds of emaciated goats. Camels pathetically chew their cud, whilst evil-looking vultures hover incessantly above the settlement, their large scraggy wings flapping ominously.

We shall certainly not come here to end our days.

Those who have decided to go for a swim just in front of the fishery had better look out, for there are always sharks on the watch for unwary bathers who choose to venture a little too far out. But everybody reports back safely to the Air France administration building, where a snack is served before we all go aboard once more. Then, off we shoot across the water again, rising skywards to start on the world's longest non-stop route.

The sun is soon below the horizon and the cocktail hour unites all passengers around the bar again.

Let us take the first dinner because I want to show you around the only spot of the aeroplane which is forbidden to passengers. And while the stewards are making up the beds, we climb the ladder to the flight deck.

Bathed in soft light, the spacious cabin is wonderfully calm. The engineer is watching over the instrument panel linked to the six engines. An electrician is changing a fuse. The radio operators, sitting on the starboard side, are "in conversation" with every radio station in the world. Roux, the navigator, stationed on the opposite side of the cockpit, has already "shot the stars" and is examining a map to compare his results with the indications received by radio. Leclaire, the famous flying-boat pilot, is captain of the aircraft. He is in the pilot's seat, but the automatic pilot is working so well that he doesn't need to make a single correction.

The co-pilot's seat is empty, for Kersaul is on the other "shift," the members of which are already snug in their bunks. We chat a little with Leclaire and with Morvan, Air France's gigantic, but gentle operations chief. René Lefèvre, the first Frenchman to fly the Atlantic and who is today in charge of the new service, also joins in our conversation.

But we must not forget that we shall soon be at Fort de France. Let us go to bed.

During the night Leclaire has been seeking and finding favourable winds higher up—it is as if the F-BANU were a sailboat, not a liner—with the result that we reach Martinique a few minutes ahead of schedule. It is a pleasant sight to wake up and find Martinique 6,000 ft. below.

Flanged by golden beaches dotted with shady palm trees, the island presents itself from the air as a gorgeous array of valleys, lakes, rivers and luxurious vegetation : a symphony in all shades of green, occasionally interrupted by the scarlet flash of what may be a tropical bird's plumage. But despite this unforgettable sight, we feel almost sorry to leave the aircraft, though we have been in the air for 15 hours.

There is not enough room here to do full justice to the charming welcome given to us by the natives ; of the delightful "doudous," the "bals à biguines," the delicious iced punches—rum, sugar cane and lime fruit—at one franc each ; the ruins of Saint-Pierre, the dormant, but menacing Mont Pelée volcano. It is just a wonderful end to a wonderful journey, which contrary to most Atlantic crossings in airliners without sleeping accommodation, has been a veritable pleasure cruise.

Blackburn S. 28/43

Many people today are of the opinion that military aircraft powered with reciprocating engines are obsolescent, and that future fighter and light bomber aeroplanes must be fitted with turbojet or propjets. But if we take the trouble to examine current developmental trends in all countries, there is no indication of piston engines being withdrawn from the field of aircraft propulsion. The operation of carrier-borne jet-propelled fighters and light bombers, for instance, is still in its early infancy, and it is likely that some time will elapse before piston engines and airscrews disassociate themselves entirely from aircraft carriers. Moreover, strong evidence to support this statement is contained in the fact that the British and U. S. naval aviation authorities are still placing plenty of orders for conventionally-powered aircraft.

In Great Britain, the most recent addition to the Royal Navy's strike fighter programme is the Blackburn S. 28/43, which Blackburn Aircraft Limited, of Brough, East Yorks, recently unveiled to the public. Though this dive-bomber/torpedo aircraft indisputably bears a certain resemblance—purely external, however—to the well-known Blackburn T. F. IV "Firebrand" attack aircraft, the S. 28/43 must be considered as an entirely new design in every respect and a complete break-away from the T. F. IV.

Construction.

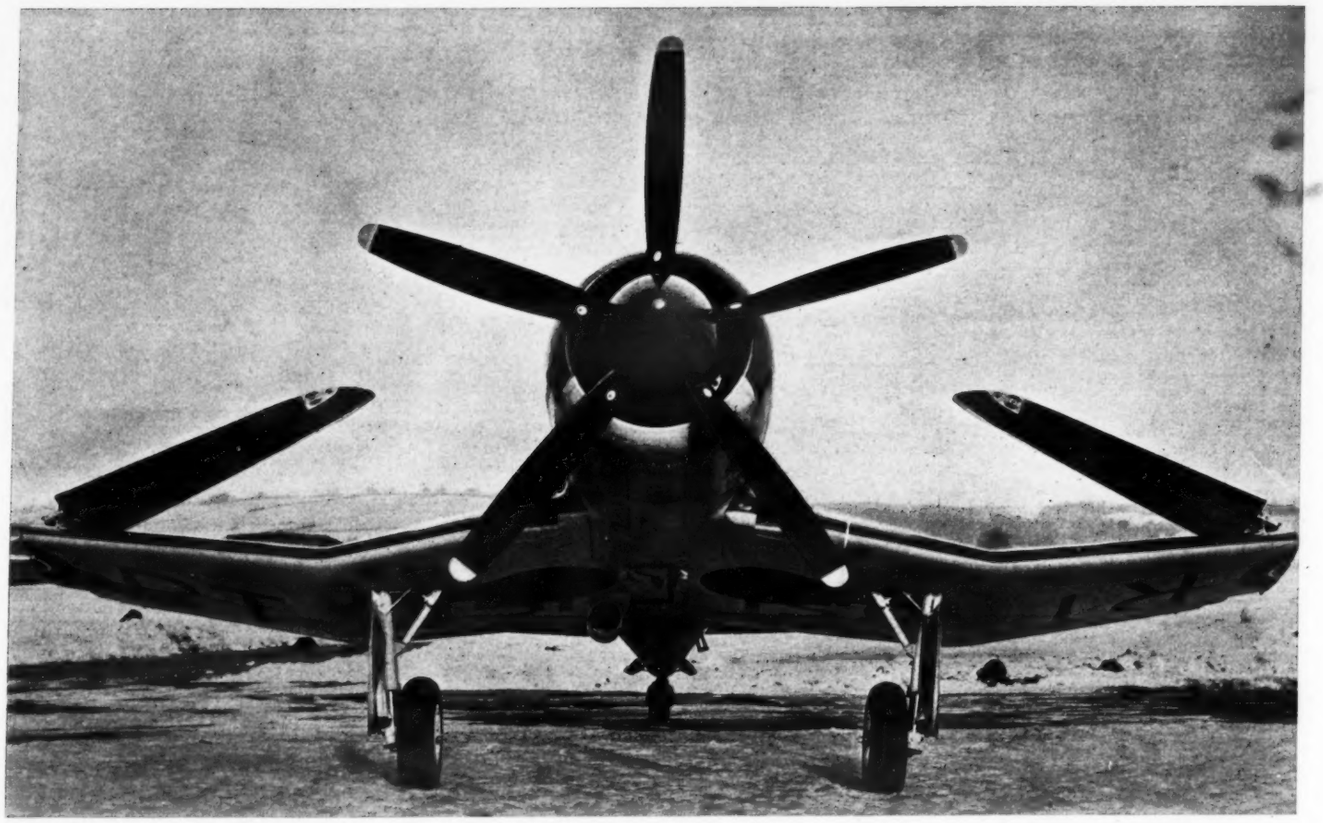
When the designers started work on the project in October, 1943, they set themselves the following main tasks. Above all, a clear view forwards : the pilot of the S. 28/43 will have a view of 15 deg. over the nose, which represents an excellent step forward in landing simplicity. Then, good low-speed control, which is a prerequisite of deck landings. In designing the wing, an effort was made to produce the simplest possible arrangement for folding the panels upwards and inwards ; the form and structure of the wing, on the other hand, were dictated by the decision to incorporate a laminar-flow aerofoil for high-speed flying.

The S. 28/43 has an inverted-gull wing, composed of a centre section and two outer wings. In relation to the fuselage, the centre section forms a downward dihedral, and the outer wings feature an upward dihedral. The two outer wings are then divided into inner and outer halves, with the result that the wings fold upwards and over—two breaks being made, an inboard one at the root end and a second break approximately midway between this point and the tip. The folding operation, which can be executed from the cockpit by the pilot while taxiing, is actuated hydraulically.

A two-spar construction has been chosen for the wing centre section, with a main spar and a front spar running through the fuselage. The incorporation of a front spar has the structural advantage of giving support to the undercarriage legs. In addition, it lends sturdiness to the bomb rack structure located beneath the wing centre section. On the other hand, the carriage of a torpedo does not affect the construction of the wing, as such a weapon can be carried at release angle beneath the fuselage and supported chiefly by the fuselage structure.

Outboard of the first break the wing centre section joins on to the outer wing, each joint featuring only three attachment points. The main spar extends through a double-bolted joint into the outer wing ; the front spar, which only extends along the outer wing for the distance of two ribs, carries the third of the three attachment points. The inner half of the outer wing, which begins at the first break, possesses a laminar flow section and is built up as a torsion box. The ribs, which are simple pressed members, have sufficient flanged lightening holes to allow for easy installation of the two wing tanks.

Front view of the S. 28/43.



The outboard halves of the outer wings folded.

Showing how the wing is folded : first, the outboard halves of the outer wings are folded inwards, and then the inner halves are folded upwards.

In the wing centre section the box-type main spar has square section booms, which are machined down to angle section in the outer wings ; towards the wing tips, this box-type spar construction is replaced by a spar with only one web carrying the ribs. The three-point attachment is again featured where the outboard halves of the outer wings join on. The ailerons attached to these parts of the wing have balance tabs which are actuated by a torsion-bar system. The outboard ailerons feature small spring-strip trimmers which are controlled electrically from the cockpit.

The wing centre section and the inboard halves of the outer wings each bear a high-lift slotted flap (four in all), actuated hydraulically. The outer flaps are equipped with automatically-operated auxiliary flaps. Just ahead of the outer flaps of each wing are a pair of dive brakes, one on the upper and one on the lower surface. Likewise working on a hydraulic principle, they lie flush in recesses when not in use, so that the smooth upper surface of the wing is in no way disturbed.

The extremely clean fuselage comprises a forward and a rear portion, both portions forming distinct sub-assembly units. The forward portion is of tubular structure assembled on a fabricated plate chassis with extruded channel-section longitudinal side members ; the rear portion is of monocoque construction.

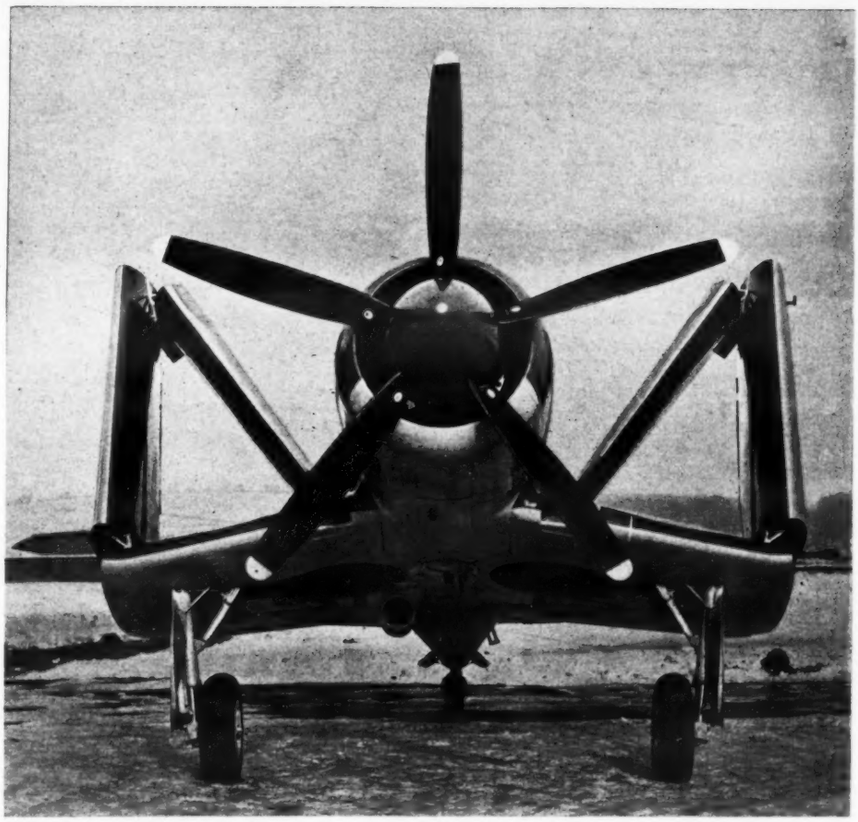
To facilitate access to the equipment in the vicinity of the cockpit, such as the oxygen and air bottles, the fuselage fuel tank and the methanol-water tank, the sides of this portion of the fuselage are covered with detachable panels.

The empennage incorporates a relatively high fin and rudder unit. The horizontal tailplane is located aft of the fin and rudder hinge and set above the fuselage rear. Rudder and elevators are fitted with electrically-actuated balance and trimmer tabs.

The Blackburn S. 28/43 is equipped with a fully-retractable conventional undercarriage, the inwards-folding main wheels being fitted with oleo-pneumatic shock absorbers. Thanks to the adoption of the gull-wing, it has been possible to make the main legs very short, thus causing an appreciable economy in weight. The retraction is hydraulic and extremely rapid, requiring only about one and a half seconds for all three wheels. Pressure is supplied by an engine-driven pump, but mechanical release is also provided in the event of failure in the hydraulic system.

Primarily for test purposes, the S. 28/43 carries no gun. Provision has been made, however, for the installation of two 0.5-in. guns in the wing centre section ; and if required, two additional guns of up to 35-mm calibre can be suspended below the wings. Meanwhile, in the event of such guns being carried, they would be installed in the place of two 500-lb. bombs which are specified in addition to the torpedo. There is also provision for the suspension of rocket projectiles beneath the wing centre section.

The power plant incorporates a Bristol "Centaurus 59" air-cooled 18-cylinder sleeve-valve twin-row radial with a two-speed supercharger. Take-off power with water-methanol injection is 2,825 H. P., whilst maximum rating is 2,880 H. P.



Folding operation completed.

The oil tank is positioned aft of the power plant, immediately below the upper panelling of the cowling. The oil cooler is beneath the cockpit and has its air intakes on the lower surface of the wing centre section. *Ba.*

SPECIFICATIONS

MAIN DIMENSIONS

Span	44 ft. 11½ in.
Span with wings folded	18 ft. 0 in.
Length	39 ft. 3½ in.
Max. height	14 ft. 6 in.

WING

Total wing area (flaps and ailerons up)		361.5 sq. ft.
Pure wing area (including flaps and ailerons, but without fuselage)		328.8 sq. ft.
Flap area :	Centre-section flap	15.34 sq. ft.
	Outer wing flap	14.50 sq. ft.
Centre Section :	Chord at root	11 ft. 6.5 in.
	Negative dihedral	6° 35'
	Leading-edge sweep-back	15° 47'
Outer wing :	Chord at root	9 ft. 4.75 in.
	Chord at tip	4 ft. 2.48 in.
	Dihedral	9°
	Leading-edge sweep-back	15° 42'

EMPENNAGE

Elevator unit :	Chord at root	5 ft. 10.5 in.
	Chord at tip	2 ft. 11.4 in.
Elevator unit area (including elevator)		73.7 sq. ft.
Fin and rudder area		41.03 sq. ft.

FUEL SYSTEM

Wing tanks, each	92 Imp. galls.
Fuselage tank	52 Imp. galls.
Wing drop tanks, each	45 Imp. galls. or 90 Imp. galls.
Centre drop tank	100 Imp. galls.
Methanol-water tank	10 Imp. galls.
Max. oil supply	24¼ Imp. galls

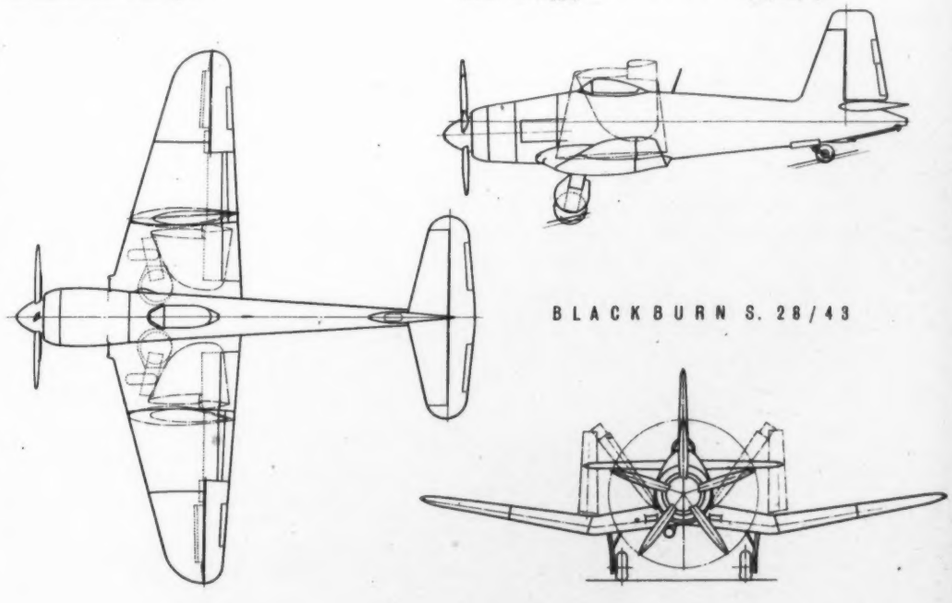
Engine cooling is assisted by a fan mounted on the spinner back-plate and controlled by gills located on either side of the engine and worked electrically.

Air for the supercharger, located at the rear of the power plant, enters through an intake in each wing centre-section leading edge, the intakes being protected with ice guards. Two additional air intakes, equipped with filters, are located below the centre section. These have electrically-actuated shutters which are controlled from the cockpit.

Built up on the "power egg" principle, the engine is bolted to a mounting ring, in turn supported by a tubular structure making a four-point attachment with the airframe. In order to simplify maintenance and servicing, the cowling is composed of hinged panels which are secured by quick-release toggle fasteners.

The airscrew is the hydraulic c. p. constant-speed five-blade model manufactured by Rotol Limited, which measures 12 ft. 9 in. in diameter.

Fuel is carried in two wing tanks, each of 92 Imp. galls. capacity, and a central fuselage tank of 52 Imp. galls. Two jettisonable wing tanks of 45 or 90 Imp. galls. volume are adaptable if it is desired to increase the range of the S. 28/43. If the smaller-capacity drop tanks are fitted, however, an additional centre drop tank of 100 Imp. galls. can be carried beneath the fuselage.



BLACKBURN S. 28/43

The Air Hostess Told Us ...

The Dither of the Disks.

Our favourite air hostess tells us that she feels as if she had gate-crashed into the lives of a married couple, what with all these saucers flying around.

Everybody, according to the papers, is puzzled, alarmed, baffled, mystified, in the dark and concerned, in other words, completely up a tree. Esmeralda does not believe that those " enemies of democracy " are at their slick tricks again, but she is concerned because none of the baffled and alarmed individuals know what is puzzling and mystifying them. This state of mind has infected even such illustrious bodies as air ministries and air commands : a general of the U. S. Army Air Forces is reported " studying the situation, " a French Air Ministry official tried to get the " straight story " from the European Edition of the *New York Herald Tribune.*

Esmeralda thinks she will join the Intelligence Service and tell them all about this airminded hardware. She has reports from " usually reliable sources " from forty-three out of the forty-eight States in the U. S. A., from Britain, Canada, Australia and South Africa, from Persia, China and Japan, from France, Italy, Holland, Denmark and Germany. The eyewitnesses in Boise, Idaho, in Zabool and Sarbisheh in Persia, in Nangking, China, and Tibirke in Denmark can't all be wrong.

The saucers are easily recognised by their shape. They look like golden disks or silver dishes, or gramophone records six inches or two hundred feet in diameter. They are luminous flapjacks standing on end. They have perspex domes and resemble washtubs the size of a five-room house. They look like shield-shaped stovepipes emitting noise and varicoloured fire. They are predominantly orange and resemble burning strawhats. They have motors with propellers attached in the centre and do slow rolls.

Should you fail to recognise them by their shape, you spot them by their actions, which are equally clear and well-defined. The disks usually " speed. " They skip through the sky or skim through the air at stunning velocities, normally westward, northward, southward or eastward. They circle for hours. They operate in loose groups of 35 or in single file ; in South Africa *two* were sighted flying in " Vee " formation. They rotate, flutter like leaves, emit red fire in front and blue fire in their wake. They gain altitude and disappear, land and disappear, fall into fields with trails of blue fire and disappear—or convert themselves into the remains of thoroughly different objects

At regular intervals the Dither of the Disks receives a shot in the arm. One chap discovered the remnants of a small weather balloon near Roswell, New Mexico, and an Alderman at Amsterdam, N. Y., found something " carbonlike with a tendency to crumble. " Both identified their finds as celestial crockery. A big American department store has offered 5,000 dollars for a flying saucer, dead or alive, to maintain its reputation as the store with the greatest variety of saucers in Philadelphia. On July 11th a saucer was found at Twin Falls, Idaho, another somewhere in Wisconsin. The first looked like " cymbals used by a jazz band drummer, placed face to face, " the second was fitted with a small motor the size of a fist, and a radio tube. The military authorities refuse to comment. Perhaps they know something.

The Flying Saucer Saga has brought the peoples of the earth close together, with exceptions, of course ... The nations see eye to eye on this question of the flying saucer. They are more unanimous than on the problem of the flying commercial aeroplanes. It was easier to establish the Flying Saucer League than international collaboration in civil aviation. It just shows how dumb people are.

Flight Clubs.

Esmeralda says she is going to change her job. She wants to be a night club hostess and still fly, and now she has a chance. Ciros, the famous London night club, is organising flights to South Africa, where you can spend your sterling at your discretion—an attraction for English holiday-makers. The night club's passengers will fly in Douglas DC-3's which, contrary to expectations, will also fly by day.

Our favourite hostess says that the DC-3's should be used to land patrons on the former aircraft carrier " Albatross " of the British Royal Navy, which is to be converted into a floating ballroom and club and moored offshore near Torquay, in the South of England. Esmeralda feels sure that the air crews would have a good time in the air, as well as while waiting to take off again from the other end. — Comments by the converted troop transport aeroplanes and the aircraft carrier on their new cargos would be interesting. Unfortunately, they haven't learned to talk.

P. A. B.

Full-Span Flap and Aileron Combinations

By Dr. Alexander KLEMIN, New York

(Concluded) [1]

B3 — Retractable Ailerons with Guide Ailerons on P-61

(Ref. 9). It is clear from the discussion of the curved plate retractable ailerons that it is in the hinge moment characteristics that their main defect lay. The hinge-moment characteristics of retractable ailerons, or retractable-arc spoilers, can be varied considerably by changing the thickness of the spoiler along its chord, the angle of the upper surface of the spoiler, or the distance between the spoiler pivot axis and the centre of curvature of the spoiler plate. Many engineers seem to believe, however, that to secure desirable stick feel with curved plate ailerons, some auxiliary device is needed. Such an auxiliary device is shown in Fig. 10, where small conventional ailerons (guide ailerons), located near the wing tips, are combined with retractable-arc spoilers.

Wheel-force and rolling performance characteristics were measured in flight with both spoilers and ailerons in operation, and then with only spoilers in operation. With the combination, characteristics were satisfactory. For spoilers alone the wheel forces were very small, though their variation was satisfactory. Rolling velocities with spoilers alone were only one-third less than those obtainable with the combination of spoilers and guide ailerons. At small wheel deflections, the use of the guide ailerons introduced just the right amount of hinge moment to improve the wheel characteristics, particularly at low speeds. Yawing characteristics of the combination were favourable at high speeds and moderate speeds, and only slightly unfavourable at landing speeds. The maximum speed may be reduced by the increased profile drag of the small spoiler projection required to maintain wings level in flight ; the guide ailerons offer advantage in this respect. No lag was reported.

It is true that the use of guide ailerons makes the span of the flap less than full-span. But the overall characteristics are so satisfactory as to justify a slight sacrifice in lift increase.

B4 — Plug-Type Spoiler-Slot Aileron

(References 8 and 12). Curved plate retractable ailerons placed far back along the chord are effective as soon as they project above the surface of the wing. Flight tests with the P-61 indicated, however, that roll effectiveness with small spoiler projections could be improved either by opening a slot just behind the spoiler or by sealing the slot of the lift flap. (Sealing the flap slot had, unfortunately, detrimental effects on the lift and drag of the wing with flaps deflected.) It will also be recalled that the hinge moment characteristics did not give the pilot good " stick feel ."

The Plug-Type Spoiler-Slot Aileron was evolved to overcome these objections and produce the almost perfect control.

Wenzinger and Rogallo (Fig. 11) show an early form of the plug-type spoiler-slot aileron. This included a circular plug, slots and a plate, and opened a slot through the wing as the plug was projected into the air stream. Wenzinger and Rogallo (Ref. 8) considered the device promising. The characteristics of this early form of plug-spoiler-slot aileron may be briefly summarised as follows: (1) Downward deflection is not effective. (2) With the split flap deflected 40°, roll

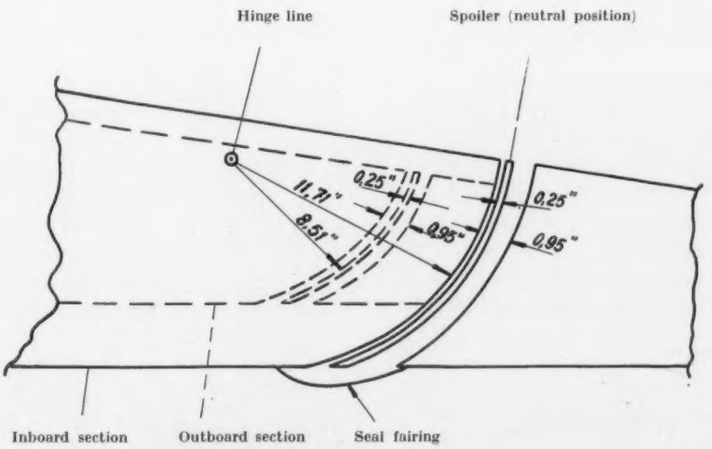


Fig. 10 : Curved plate spoiler with guide ailerons on the Northrop P-61

[1] Cf. "Interavia, Review of World Aviation" No. 7, July, 1947, P. 38-42.

effectiveness is ample, but rolling moment still waits on .02 *c* projection of the plug. (3) Yawing moments are favourable except at very large coefficients of lift. (4) Hinge moments vary linearly with aileron projections, and are large enough, but there is always a tendency to *negative* hinge moments when the aileron projects only slightly above the wing surface.

Fig. 12 shows two plugs of a later date. The number of parameters becomes bewildering: slots through the wing; slots and passages through the aileron; vents; moveable plates; and differential movement of the plate with projection of the aileron.

So many parameters are involved, and so many tests have been made, that it is difficult to draw general conclusions. The effect of reducing or sealing the vents was: (1) to reduce the values of hinge moment coefficients for full aileron deflection; (2) give a region of hinge moment instability near zero deflection; (3) improve rolling moment coefficients at small aileron projections; (4) increase rolling moment coefficients at large angular deflections. Yawing moments were only adverse for the condition with flap fully deflected and at a large angle of attack. It was found that the moveable plate had a marked effect on the hinge moments and the following seems the best compromise: (1) Set plate at a small initial negative angle to provide stable hinge-moment variation at low aileron deflections. (2) Provide a differential linkage such that, with large aileron deflection the plate deflection becomes positive to reduce the maximum stick forces.

Lowry and Riddel summarise the situation very well by writing: " The results of this investigation indicate that a plug aileron will provide satisfactory lateral control on a tapered-wing airplane equipped with full-span slotted flaps. For satisfactory results, it is essential either to obtain the optimum amount of vent opening or to provide means for deflecting the plate relative to the aileron."

B5 — Slot-Lip Ailerons

(Ref. 5.) Shortal has described a slot-lip aileron which in many ways is well adapted to the full-span flap (see Fig. 13). With this combination it is possible to reduce lag to a minimum, although the initial roll is still sluggish. Rolling, yawing and hinge moments become satisfactory. Stall of the outer portions of the wing is delayed by the slot. Unfortunately the slot-lip aileron means

Fig. 13: Slot-lip aileron

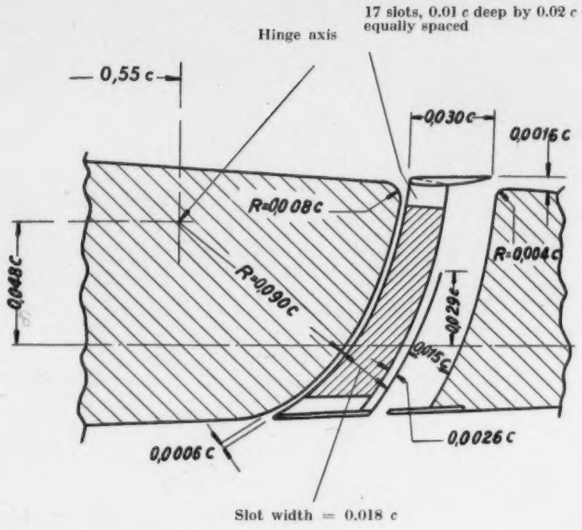


Fig. 11: Early form of plug-type spoiler-slot aileron

structural complications. The added drag is about 10 per cent. of the wing drag at high speed and about 35 per cent. of the wing profile drag in the climbing attitude. Unsuitable for high-performance airplanes, this form of slot-lip aileron should interest designers seeking good control and safety in relatively slow airplanes.

The slot-lip aileron described in the previous paragraph is unsatisfactory mainly because of the large increase in drag coefficient which the open slot introduces. Wenzinger and Bamber (Ref. 10) show that this defect disappears when the slot-lip aileron is placed immediately ahead of the slotted aileron as in Fig. 14. But other difficulties appear.

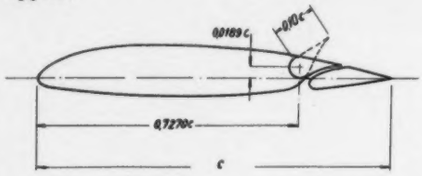
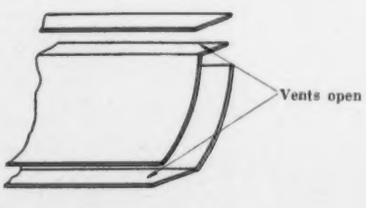


Fig. 14: Slot-lip aileron placed immediately in front of main flap slot

For the condition from $\delta_f = 0^o$ to $\delta_f = 20^o$, the aileron has to be moved through 10^o before any appreciable rolling moment is developed—though the lag in rolling motion with control movement is probably less than 1/10 second. The yawing-moment coefficients are generally adverse for small aileron deflections and positive for large aileron deflections. These moments become algebraically less as the flap angle is increased. Because the aileron is located in a region of low pressure on the upper surface of the wing, large hinge moments are required to hold the aileron neutral and they increase with flap deflection. As the aileron is moved up the moments change sign and force must be applied to move the aileron higher. The slopes of the curves of C_{h_a} (hinge moment coefficient) against δ_a are irregular and for small flap deflections they change sign. With manual control, it would be hard to obtain satisfactory stick forces, without some complicated linkage.

It may also be pointed out that the slot-lip aileron of Fig. 14 in its neutral position lies close to the lift flap when retracted. Only small positive aileron deflections may therefore be used, and for the retracted condition, a complicated linkage or cam is necessary. That is why the suggestion was made of using a conventional flap-trailing-edge aileron with flaps retracted, and a slot-lip aileron for use with flaps deflected—a combination we shall discuss later.



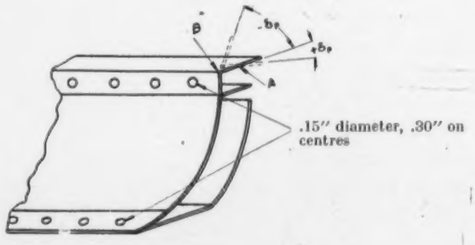


Fig. 12: Two plugs of a later date

B6—Trailing Edge Ailerons in Rear of a Slotted Flap.

(Ref. 10). Fig. 15 shows the plain ailerons placed at the trailing edge of a slotted full-span flap. Wind tunnel tests showed only

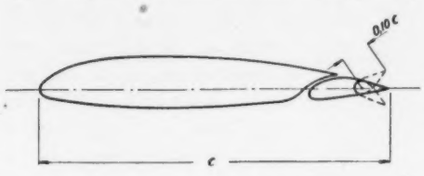


Fig. 15: Plain ailerons in rear of a slotted flap

one unfortunate characteristic of this device: the value of C_l at any fixed aileron deflection *decreases* with the flap setting, whereas for good aileron functioning *increase* is required. Thus for large flap deflections the rolling moment coefficients would be too small. The values of the yawing-moment coefficient are adverse and large, particularly at high angles of flap deflection. Hinge moments are comparatively small for small flap deflections but become large with increasing flap deflection. Thus the trailing edge ailerons would be, on the whole, satisfactory only for small flap deflections.

The full flight tests of Ref. 13 confirmed the wind tunnel tests just described. A Brewster F2A-2 airplane was equipped with partial-span narrow-chord ailerons on the trailing edge of a full-span NACA slotted flap. These tests were made with the same technique as previously defined. At a flap deflection of less than 20°, the tests showed "adverse" yawing moments, which were considered undesirable but not objectionable by the pilot. For flap deflections greater than 20° the aileron effectiveness decreased rapidly until at 42° flap deflection the maximum effectiveness obtained at low airspeeds averaged only about 45 per cent. of the effectiveness with flaps retracted.

The following remarks apply in general to trailing edge ailerons placed in rear of slotted flaps: The aileron chord has to be limited to about 10 per cent. of the wing chord, and aileron span has to be unduly long accordingly. With flap deflected, the up-going aileron retains its effectiveness; the down-going aileron loses its effectiveness. A pronounced differential may be helpful but can also cause overbalance if the ailerons are designed for close aerodynamic balance when the flaps are retracted. It is easy to see why there should be adverse yawing moments with flaps deflected: that side of the wing where the aileron is moved up loses lift, has a decrease in induced drag and a decrease in profile drag. Again it should be remembered a narrow-chord aileron can never equal the power of a wide aileron.

The general conclusion would seem to be that trailing edge ailerons placed in rear of the main flap would be satisfactory only for quite small main flap deflections.

While discussing narrow-chord rear-edge ailerons, it is appropriate to recall a device which has often been tried and then abandoned by designers, namely "drooped" ailerons. Ailerons are placed at their usual position towards the tip of the wing, are drooped for lift increase, and operated differentially when the flaps are deflected. Sometimes a single flap, or the rear edge of a double flap, is used in similar fashion. The functioning of such devices is very similar to the functioning of the narrow-chord ailerons. In the drooped position, the effectiveness of the down-going aileron is low, yawing moments are certain to be adverse, and the problem of balancing is difficult.

B7 — Trailing-Edge and Slot-Lip Ailerons Combined

The previous discussion of the trailing-edge ailerons indicated that they were only satisfactory at small main flap deflections. On the other hand the slot-lip aileron is more satisfactory at large flap deflections. What more natural than to combine the two? Wetmore and Sawyer (Ref. 14) describe precisely such a combination. Fig. 16 shows a sectional view of the wing of the F2A-2 single-seater having a wing area of 208.9 sq. ft. The trailing-edge ailerons were of narrow chord and large span and constituted the trailing-edge portions of the flaps. The ailerons were of the sealed, internally-balanced type. These ailerons continued in operation as the flaps were deflected from neutral to about 18° when an automatic change-over device locked the ailerons in neutral position with respect to the flaps and engaged the slot-lip ailerons. The slot-lip ailerons were essentially upper-surface spoilers, which in the neutral position form the lip of the flap slot as shown in Fig. 16. These ailerons were in operation for all flap deflections from 18° to full down and were locked in neutral for smaller flap deflections.

The flight tests indicated excessive elasticity in the trailing-edge aileron system which reduced the aileron-deflection range attainable in flight to $\pm 17.5°$. The seals of the internally-balanced ailerons were not perfect. Stick forces were rather heavy. There was some tendency to over-balancing of the slot-lip aileron system, which had to be counteracted by spring action in the control system. But on the assumption that the structural elasticity could be decreased, and other minor improvements introduced, it would be reasonable to draw the following conclusions:

1. The trailing-edge ailerons would readily produce a value of

$$\frac{pb}{2V} \geq .07$$

which is generally accepted as satisfactory for flap settings up to 18°. Within this range of flap settings they would show no perceptible lag in action.

2. With the slot-lip aileron taking over at a flap setting of over 18° the ineffectiveness of trailing-edge ailerons at high flap settings would be met.

3. The slot-lip ailerons coming into play at appropriately high flap settings would show no lag.

4. The slot-lip ailerons would show a maximum effectiveness of .130 instead of the .07 criterion.

Unless the design of such a system introduces too much mechanical complexity the appropriate combination of trailing edge and slot-lip ailerons seems promising.

B8 — Flight Tests of a Variety of Spoilers

(Ref. 4). Space considerations will not permit review of the flight tests made on a variety of spoilers (circular arc and plug type) on the Northrop P-61A and the Vought Sikorsky OS2U-2. Moreover these flight tests merely confirm previous findings, for the most part. There are two points which deserve special attention:

Behaviour at the Stall

In one combination tested, slotted flaps extended 82 per cent. of the semi-span with a circular-arc spoiler ahead of them and conventional "guide" ailerons for the rest of the span. Abrupt rudder-fixed rolls were made, with and without the use of the guide ailerons. The roll following abrupt deflection of the control was in the correct direction and the yaw was desirably low. The pilot considered the lateral control in the stall region to be excellent, though due in part probably to the excellent stall pattern of the wing itself—characterised by an early wing-centre-section breakdown.

Characteristics in Inverted Flight

With the tip ailerons fixed in the neutral position, the effectiveness of the spoilers was tested in inverted flight, which was obtained by an abrupt roll to the left. The airplane was then rolled abruptly to the right. The spoilers produced a rolling motion in the correct direction, the lag was not excessive, and the yawing moments were favourable. The pilots considered spoiler effectiveness in inverted flight to be adequate.

A Chart of Maximum pb/2V

In Plate II curves of maximum $pb/2V$ are plotted against spoiler angle at varying

indicated speeds. These curves show how well a combined spoiler and tip aileron system works out. The effectiveness varies linearly with the aileron deflection, and for any aileron deflection is practically independent of the speed.

EFFECTS OF HIGH MACH NUMBER ON SPOILERS

(References 15 and 16). There is little known on this topic, whose importance grows with the speed of flight.

The rolling moment coefficient due to projection of a spoiler located at 0.75 *c* increases rapidly up to a Mach number of 0.72 (at which value a shock probably occurs on the upper surface). Between Mach number of 0.72 and 0.75, the rolling moment coefficient of the spoiler decreases *more* rapidly than does the effectiveness of conventional type ailerons. Hence a spoiler in this range of Mach numbers no longer offers advantage over the conventional aileron.

At supercritical Mach numbers the spoiler effectiveness can be improved by locating it forward of the 0.75 *c* position. But the spoiler then suffers lag and ineffectiveness for small projections. Further research is needed. More information is also needed on the hinge moments at high speed and on the prevention of vibration and buffeting at very high speeds.

CONCLUSIONS AND RECOMMENDATIONS

If this article has any importance, this lies in the conclusions and recommendations, though the recommendations may be suggestions for further study. But a review had to be made of many devices, good, bad, or indifferent, for the conclusions to carry conviction :

1. It is important to know what not to attempt. Therefore it was worth studying the test results of the group of early lateral controls, retractable split flap with conventional ailerons ; auxiliary surface ailerons ; external ailerons ; upper surface ailerons ; hinged flap spoilers ; and flap-type deflectors, if only to learn that they can be dismissed from consideration. In the light of our present knowledge, it seems remarkable that so much time and effort was spent on their development and test. But engineering research never proceeds in a straight line. There is always " du tâtonnement."

2. It is perfectly possible to have satisfactory lateral control in combination with a full-span flap, and to meet requirements which were written at the very beginning of this article.

3. Every one of the devices in the second more modern group of lateral controls has some value either singly or in combination with some other device, either as an end in itself, or as an evolutionary step. It is clear, however, that " drooped, " conventional ailerons can be forgotten ; that trailing edge flaps or narrow-chord ailerons placed in rear of the main flaps cannot be effective in themselves ; and that the slot-lip aileron, of the type in which there is a lip partially covering a slot going right through the wing, can be discarded because its useful qualities will not compensate for the increase in profile drag which it inevitably produces.

4. There appears to be one indispensable element in the design of a lateral control for use with a full-span flap : a spoiler working on the upper surface of the wing to reduce lift and increase drag on the side of the wing to which it is applied. Moreover the spoiler must be of the retractable, *not* the hinged flap type.

5. The spoiler must be located far back on wing chord, otherwise it will have two drawbacks : an objectionable lag, before any rolling moment is established, and appreciable projection above the wing surface required before any rolling moment is produced.

6. The spoiler should be located at least further back than 0.7 *c*, even though final rolling moments at high positive lift coefficients are somewhat less for such locations than for spoilers located further forward.

7. Another reason for locating the spoiler far back on the wing surface is that the rolling moment produced will then be roughly proportional to the lift coefficient, a basic requirement.

8. The spoiler on the upper surface is a device for producing rolling moment by decreasing lift and increasing profile drag. Decreasing lift reduces the induced drag, but the increase in profile drag is likely to be larger. Hence the spoiler is always likely to produce a favourable yawing moment over a large part of the angle of attack range. The conventional aileron is always likely to produce an adverse yawing moment.

9. Another advantage of the spoiler is that it produces less pitching moment than a rear-edge flap or aileron. Hence it is not likely to twist the wing and reduce its own effectiveness.

10. The retractable spoiler is likely to be effective at or near the stall.

11. A retractable spoiler which is satisfactory in normal flight is likely to be satisfactory in inverted flight.

12. The retractable, circular-arc type of spoiler placed well back on the upper surface of the wing is satisfactory in rolling moment effectiveness, satisfactory in the variation of rolling moment with C_L and angle of aileron deflection, satisfactory in yawing moment, is sufficiently free from lag, and is effective at small aileron projections. The drawbacks to the control are negative hinge moments over a sizeable spoiler-angle range near zero, and control forces that are too light for proper stick feel and self-centring.

13. If the concept of a full-span flap is so far abandoned that the circular-arc spoiler is combined with small "guide" ailerons at the tip, the conventional ailerons predominate improving feel and appropriate stick forces.

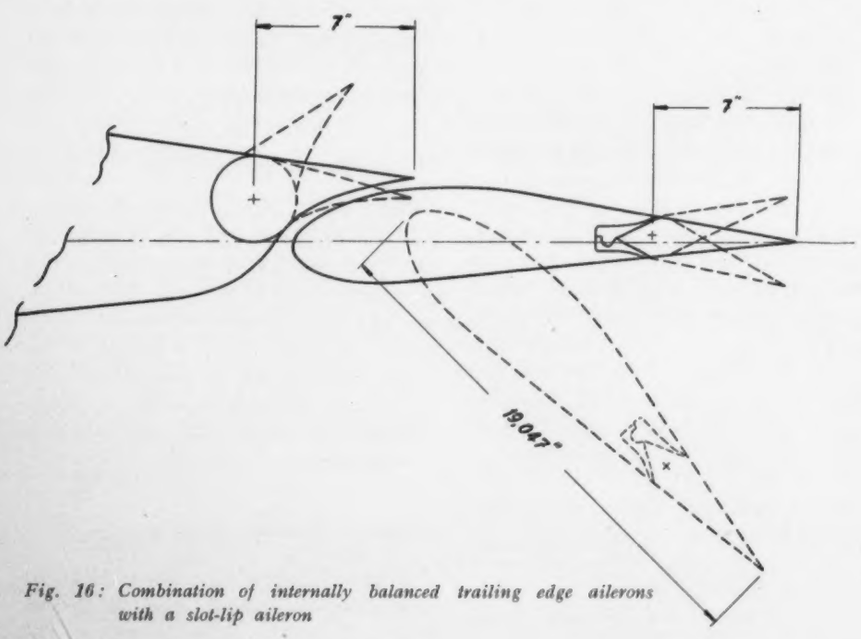


Fig. 16 : Combination of internally balanced trailing edge ailerons with a slot-lip aileron

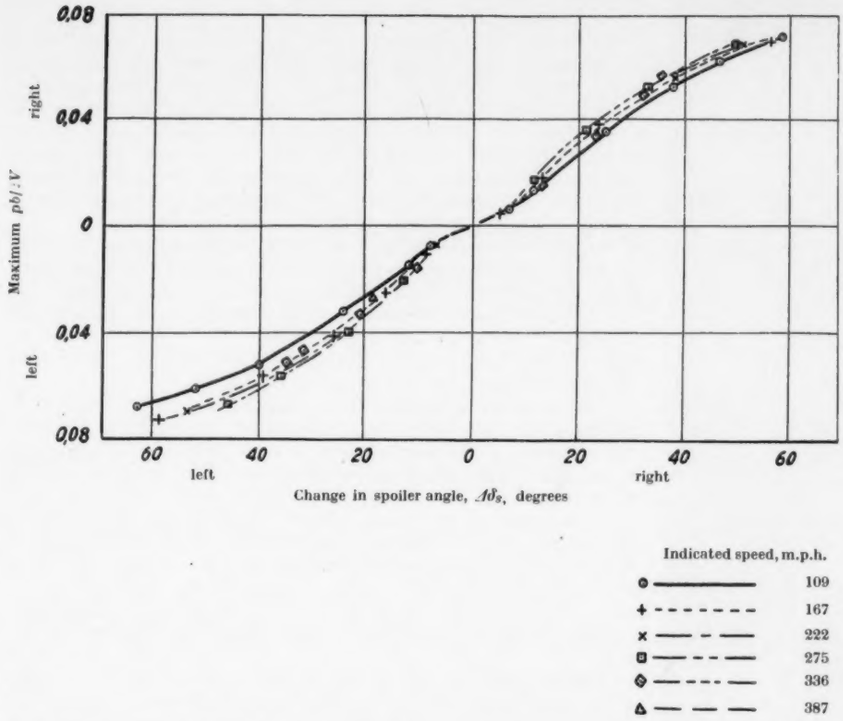


Plate II : Curves of pb/2V for a combined arc and guide aileron control (with power on, clean condition)

The combination of circular-arc spoilers and small guide ailerons should be completely satisfactory. A subsidiary advantage of the guide ailerons is that wing can be kept level by the ailerons, and drag of projecting arc at high speed is avoided.

14. It is possible to improve the circular-arc spoiler in regard to stick feel without the use of guide ailerons by placing the centre of curvature of the spoiler a small distance above the hinge line. Large effects on stick forces result from small offsets. Unfortunately, it is then necessary to increase the gap in the upper wing surface, which is a detriment to aerodynamic effect.

15. An alternative approach to satisfactory lateral control lies in the plug-type spoiler-slot aileron. Careful design is necessary of slots and vents, and a plate at the top of the spoiler with a carefully worked out differential linkage. Plug-type spoiler-slot designs have proved satisfactory in flight tests. They appear somewhat fussy.

16. Trailing-edge narrow-chord ailerons placed at the rear of the main flap are only satisfactory for small flap deflections.

17. The slot-lip aileron of the type which is placed immediately ahead of the slotted flap is not satisfactory at low flap deflections because the aileron has to be moved through 10° or so before rolling moment is developed ; hinge moments and yawing moments are unsatisfactory.

18. But both wind-tunnel and full-flight tests indicate that the following can be a most desirable combination : (a) slot-lip aileron together with narrow-chord ailerons at rear of main flap ; (b) the narrow-chord ailerons to work only at low flap deflections ; (c) the control gear system so worked out that above a certain flap deflection the slot-lip aileron would automatically take charge.

19. The combination of narrow-chord ailerons with a circular-arc retractable spoiler might be worth considering.

20. The rolling moment power of a spoiler is measured accurately by the height of its projection above the surface of the wing, and the exact type of spoiler employed is immaterial.

21. Since the spoiler is always more likely to give favourable yawing moments than conventional ailerons, the spoiler type of lateral control is the more suitable for the " two-control " airplane in which the rudder is eliminated.

22. While, as stated previously, it is quite possible to have satisfactory lateral control for a full-span flap, it is probable that the use of two devices instead of one will be necessary.

23. While there are now several avenues of approach, the most straight-forward way would be to combine a circular-arc retractable spoiler with quite small guide ailerons.

24. Design problems become more difficult as speed and Mach numbers increase, and a great deal of research will be necessary.

25. We have not in this article considered the use of tabs or other balancing devices, nor the control gear, nor the mechanical design problems of differential gear, nor the structural loads introduced, nor the possibilities of vibration or flutter, nor the requirements of structural rigidity. If all such problems are superimposed on the problems that have been considered, it becomes clear that the design of a satisfactory lateral control system for a full-span flap calls for long investigation and design skill in any particular case.

References

1. WEICK, Fred E., and JONES, Robert T. : *Résumé and Analysis of NACA Lateral Control Research*, NACA Technical Report No. 605, 1937.

2. GILRUTH, R. R., and TURNER, W. N. : *Lateral Control Required for Satisfactory Flying Qualities Based on Flight Tests of Numerous Airplanes*, NACA Technical Report No. 715, 1941.

3. PEARSON, Henry A., and JONES, Robert T.: *Theoretical Stability and Control Characteristics of Wings with Various Amounts of Taper and Twist*, NACA Technical Report No. 635, 1938.

4. SPAHR, Richards : *Lateral Control Characteristics of Various Spoiler Arrangements as Measured in Flight*, NACA Technical Note No. 1123, 1947.

5. SHORTAL, Joseph A. : *Wind-Tunnel and Flight Tests of Slot-Lip Ailerons*, NACA Technical Report No. 602, 1937.

6. JOHNSON, Harold I. : *Procedure for Flight Tests of Aileron Characteristics of Airplanes*, NACA Wartime Report, July, 1943.

7. SOULÉ, H. A., and MCAVOY, W. H. : *Flight Investigation of Lateral Control Devices for Use with Full-Span Flaps*, NACA Technical Report No. 517, 1935.

8. WENZINGER, Carl J., and ROGALLO, Francis M. : *Wind Tunnel Investigations of Spoiler, Deflector and Lateral Control Devices on Wings with Full-Span Split and Slotted Flaps*, NACA Technical Report No. 706, 1941.

9. NACA-Industry Conference on Personal Aircraft Research, Langley Field, September, 1946.

10. WENZINGER, Carl J., and BAMBER, Millard J. : *Wind Tunnel Tests of Three Lateral-Control Devices in Combination with a Full-Span Slotted Flap on a NACA 23012 Airfoil*, NACA Technical Note No. 659, August, 1938.

11. WETMORE, J. W. : *Flight Tests of Retractable Ailerons on a Highly Tapered Wing*, NACA Technical Note No. 714, July, 1939.

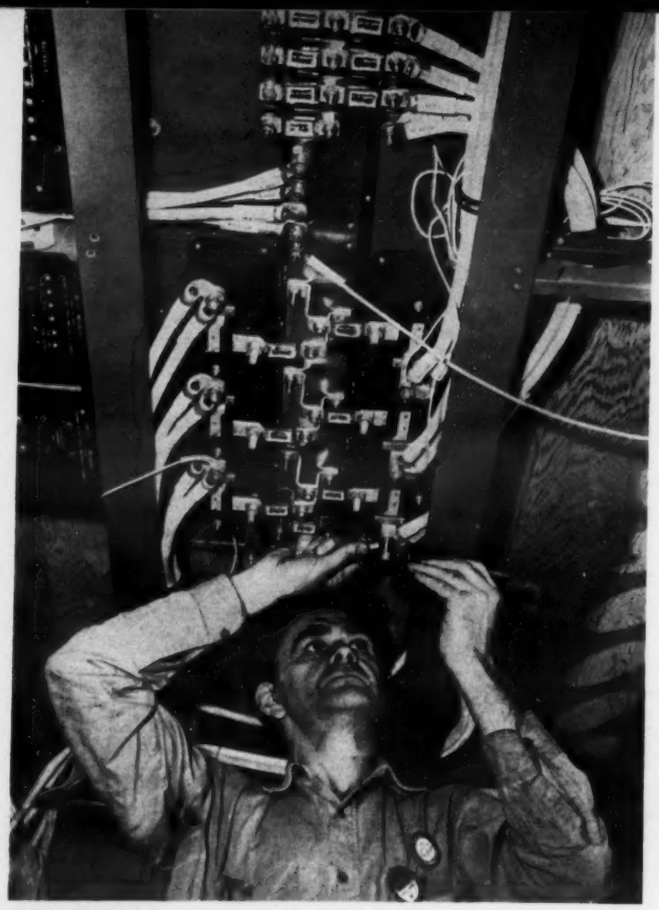
12. LOWRY, John G., and LIDDELL, Robert B. : *Wind Tunnel Investigation of a Tapered Wing with a Plug-Type Spoiler-Slot Aileron and Full-Span Slotted Flaps*, NACA ARR, July, 1942.

13. SAWYER, Richard H. : *Flight Measurements of the Lateral Control Characteristics of Narrow-Chord Ailerons on the Trailing Edge of a Full-Span Slotted Flap*, NACA Technical Note No. 1188, February, 1947.

14. WETMORE, Joseph W., and SAWYER, Richard H. : *Flight Tests of F2A-2 Airplane with Full-Span Slotted Flaps and Trailing-Edge and Slot-Lip Ailerons*, NACA ARR 3L07, December, 1943.

15. LAITONE, Edmund V. : *An Investigation of the High-Speed Lateral-Control Characteristics of a Spoiler*, NACA ACR No. 4C23, 1944.

16. LAITONE, Edmund V., and SUMMERS, James L. : *An Additional Investigation of the High-Speed Lateral-Control Characteristics of Spoilers*, NACA ACR No. 5D28, 1945.



Main power junction, where the outputs of the four generators and two alternators are centralised for distribution, is in ceiling of Stratocruiser lounge.

Electricity on the "Stratocruiser"

Few of the passengers travelling across continents and oceans in modern four-engined airliners probably realise that their aircraft literally carries an electric power plant aboard. Small items such as aisle and reading lights, etc., form part of the normal fittings, and nobody ever looks for the source of the electric current. These accessories consume only a negligible portion of the electricity which is required for the safe operation of the aircraft or to maintain the comfort of the passengers.

Whilst in an average modern airliner electricity accomplishes forty or fifty different tasks, more than 100 duties are performed by electric current on the *Boeing 377 "Stratocruiser."* Long experience has shown that an electric system offers a high degree of reliability, low fire hazard and low maintenance cost. For this reason the Boeing Aircraft Co. uses electricity in place of pneumatic or hydraulic systems for such tasks as lowering and raising the landing gear, etc.

More than 70 kilowatts are required to perform the electrical chores aboard the "Stratocruiser," enough to supply the domestic needs of an American community with a population of about 700 people. This power must be supplied by an installation weighing only a small fraction of what a comparable ground installation weighs. In effect, the generating and distributive electrical equipment on the "Stratocruiser" weighs only 2,523 lbs. and is equal in reliability to the best stationary system.

The electrical system includes ten miles of wire of various sizes; aluminium wiring, rather than copper, is used in the larger wire and cable sizes, resulting in a weight-saving of 265 lbs. Six D. C. generators of 9 kilowatts each and 2 alternators, all driven by the aircraft's four engines, supply the required energy.

The biggest demand for current is from the landing gear motors —two for the main gear, one each for nose-wheel and tail skid. They draw a total of 616 amperes when in operation; since it takes the landing gear only 9 seconds to operate, however, this demand is a fleeting one. The generators turn at speeds ranging from 3,000 to 8,000 r.p.m., depending upon the engine speeds from idling on the ground to full take-off power, and can handle an overload of nearly 300 per cent for very short periods at cruising speed and even more at higher speeds. For two minutes a 150 per cent overload is permissible. An ingenious regulating system maintains the tension of the D. C. circuit constant at 28 volts at the main bus or point of junction; however, an over-voltage relay on each generator will disconnect it from the distribution system in case that generator's voltage builds up too high.

A greater demand for current, though of less amperage, is made by the cooling compressors in the cabin-conditioning system, which draw 450 amperes. To list all the other electricity consumers on the "Stratocruiser" would mean the compilation of an electrical catalogue: electric motors alone number 119. Of interest may be that the smallest consumer is the tiny compass light, which uses slightly more than one-hundredth of an ampere.

Two alternators supply current exclusively for heating installations. They are three-phase alternators, developing eleven kilovolt-amperes at 208 volts between phases, or 120 volts from each to ground. Their output is cut in automatically as soon as their frequency reaches 400 cycles per second.

Some tasks on the "Stratocruiser" require constant frequency alternating current. Three rotary inverters connected to the D. C. system supply this type of current. Each of the inverters performs a well-defined duty, but in case of failure of the inverter used for the operation of instruments essential for flying safety, a stand-by inverter starts up automatically and takes over the load of the other.

Finally, there is another source of electric current in the form of three 12-cell batteries. Two of them are normally connected to the main bus through a relay, charging and discharging into the main bus. The third battery serves, in emergencies, the aisle light, exit light, cockpit lights, flares and emergency radio equipment. The batteries of the "Stratocruiser" have ample strength to crank one engine. However, during a normal stop the current required for engine cranking and the operation of the air conditioning equipment is supplied by a service truck through a jack-and-plug arrangement in the wall of the aircraft.

In conclusion, a few details of the way in which the Boeing Aircraft Co. protects the distributing system against short circuits may be of interest. The main power line consists of six cables, each of which has its own fiberglas and plastics insulation and, at each end, a current limiter or "slow-blowing" fuse. If a short circuit should occur on any line, that line's current-limiter would blow, but the other five lines would continue to carry the load. Similar safety provisions are made in the power lines serving inboard and outboard engine controls, lighting system and motors in the tail section.

Outside supply of electricity for a Stratocruiser on the ground to keep air-conditioning equipment in operation while the engines are not operating.

Monocoque Construction

By N. J. Hoff, Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn

(Concluded) [1]

2. *Thick Skin Construction*

By the end of World War II the advances in aerodynamics and propulsion required a change in the structural methods employed in aeroplane construction. First the laminar flow airfoil came into use. This type of wing section has the property that over its major portion the layer of air closest to the wing, known as the boundary layer, remains smooth or laminar under normal conditions of flight. This smooth and orderly flow causes much less drag than does the irregular flow in the so-called turbulent boundary layer which prevails over the conventional types of airfoils. Thus the introduction of the laminar airflow wing permitted an increase in the high speed of the aeroplane. On the other hand the laminar boundary layer is very sensitive and changes over to a turbulent boundary layer if the flow is disturbed by any inaccuracy of the wing contour, any dimples around rivet heads, and in general by any surface roughness. Consequently an aeroplane which is expected to establish a new speed record on the basis of model tests carried out with a very smooth model in the wind tunnel may fail completely to do so if manufacturing inaccuracies or buckling of the skin, that is the sheet covering, change slightly the shape required by aerodynamic theory. For this reason conventional methods of aeroplane construction became obsolescent, at least in the case of wings, when the laminar flow wing was introduced.

Inaccuracies of the contour are equally important with any airfoil when the local velocity of the air over some portion of the wing approaches the speed of sound. In the neighbourhood of sonic speed the airflow is sensitive to any disturbance and is likely to change from one pattern to another at the slightest provocation. Shock waves may develop which create a great deal of additional drag, known as wave drag. For this reason smaller tolerances have to be maintained in modern aircraft designed to reach the speed of sound than were necessary in the earlier slower types.

As a result structural designers had to find new methods of construction that permit more accuracy in the manufacture of aeroplane parts exposed to the airflow, greater smoothness of the surface, and sufficient stability of the skin to prevent the development of buckles or wrinkles under all conditions of flight. F. R. Shanley of Lockheed Aircraft advocates the use of a thin skin provided with integral stiffeners. This structural element should preferably be manufactured in standard sizes by rolling but in the absence of a large enough demand at the present time to warrant such fabrication Lockheed milled several sheets of this kind from heavier gauge plate. Because of the integral stiffeners the sheet is very stable. No stringers or capstrips need be attached to it so that its surface is free from rivets and consequently is unusually smooth. Fig. 14 shows a section of a tab made according to these new ideas.

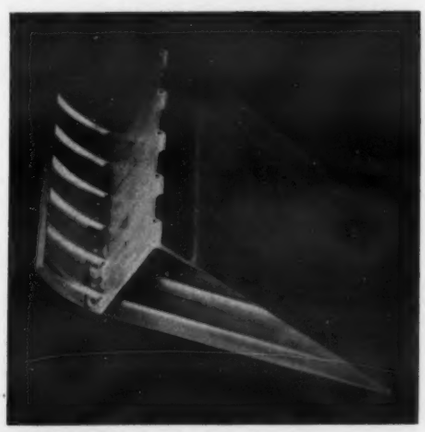


Fig. 14: Lockheed experimental tab made of thin sheet having integral stiffeners. (Courtesy of Lockheed Aircraft Corp.)

In the heavily-loaded, very thin wings of transonic and supersonic aeroplanes the thick metal skin may be the solution of the design problem. When the bending moments are large and the structural height of the wing is small, the large cross-sectional areas of material required for satisfactory strength can be more advantageously distributed over a thick coverplate than concentrated in a number of heavy stringers connected by a thin sheet covering. An aluminium alloy plate of $\frac{1}{4}$ in. to $\frac{3}{4}$ in. thickness is inherently stable and needs few reinforcing elements to prevent its buckling under the loads encountered in flight and at landing. Tests carried out with such thick panels reinforced with much lighter stiffeners often show an explosive type of buckling. Rivets shear and stiffeners break when the buckling load is reached, so that buckling is equivalent to failure in this construction.

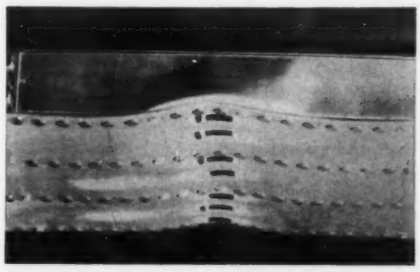


Fig. 15: Failure of an experimental bow beam having a thick cover plate. When the 1/8 in. thick stiffeners gave way. (Courtesy of Republic Aviation Corp.)

Because of its great weight the metal plate must be carefully tapered in thickness so as to eliminate all unnecessary material. This taper and the curvature of the wing profile necessitate expensive milling and pressing operations with the result that metal plate

[1] Cf. "INTERAVIA REVIEW" No. 7, July, 1947 P. 33-38.

type aeroplane wings are costly. Nevertheless they have already been used in actual aircraft. It was disclosed in January, 1947, that the Bell XS-1 rocket-propelled experimental aeroplane had wings whose aluminium alloy sheet covering varied in thickness from ½ in. at the root to ⅛ in. at the tip. The reasons for this unusually heavy covering were the small maximum thickness of the wing, only 10 per cent of the chord, and the large bending moments to which it was subjected. The XS-1 was designed to reach a speed of 1,700 m.p.h. and to withstand an acceleration equal to 18 times the acceleration of gravity.

Another solution of the design problem of very fast planes is the sandwich construction. The principle involved is simple. If two thin layers of load-carrying material are spaced apart by sandwiching between them a thick and very light, though weak, core, then the thick composite board obtained is unusually rigid for its weight and is not likely to buckle. Corrugated board, used extensively for packaging, may be mentioned as an explanation of the principle. Here of course the space between the two load-carrying outer layers of paper is connected by a corrugated sheet rather than by a continuous low-density medium. The effect, however, is the same. The large moment of inertia of the two external layers of paper held apart by the corrugated sheet does not permit buckling until high values of the compressive stress are reached.

The corrugated board principle was adopted by Lockheed Aircraft in the design of the wing of the P-38 " Lightning " fighter plane, but the paper was replaced by aluminium alloy and the corrugated sheet was connected by blind rivets with the two smooth sheets. Because of the presence of the rivets the surface obtained was not so smooth as that of the two wings just discussed. On the other hand the corrugated board type skin is very rigid for its weight.

This type of construction is not regarded as a sandwich by many structures experts. In a true sandwich skin, the faces are connected by a continuous light-weight core. Fig. 17 shows a portion of the leading edge of an experimental wing built by Skydyne Inc. The outer layers, the so-called faces, were made of Fiberglas textile and the core of expanded cellulose acetate. It cannot be established with certainty who was the inventor of sandwich construction. It was reported that the pontoons built by Sundstedt in Newark, New Jersey, in 1919 were of the sandwich type. In 1924 Th. von Kármán and P. Stock received a patent for a sandwich skin. The first really successful and well-known aeroplane designed according to the sandwich principle was the " Mosquito " fighter-bomber, built during World War II by The de Havilland Aircraft Co. and its subsidiaries in England and all over the British Empire.

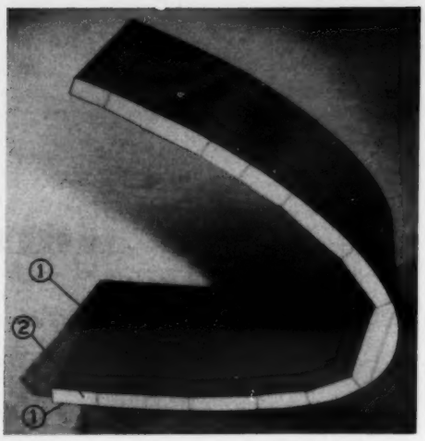


Fig. 17 : Portion of wing leading edge manufactured by Skydyne Inc. The Fiberglas textile faces are marked 1, and the cellular cellulose acetate core is marked 2.

Fig. 16 : Corrugated board type skin of Lockheed P-38 " Lightning " after strength test. (Courtesy of Lockheed Aircraft Corp.)

The construction of sandwich type fuselages and wings was made economically feasible through the development of the bag-molding technique. Of the many variants of this technique, perhaps the Vidal and Duramold processes are best known. The basic principle will now be explained with the aid of Fig. 19. The mold of half the fuselage is marked 1. Upon it are placed first the layers of the internal face, then the core material, and finally the layers of the external face, all coated with a suitable synthetic glue. The complete sandwich skin 2 and the mold are inserted into a rubber bag 3 and the entire

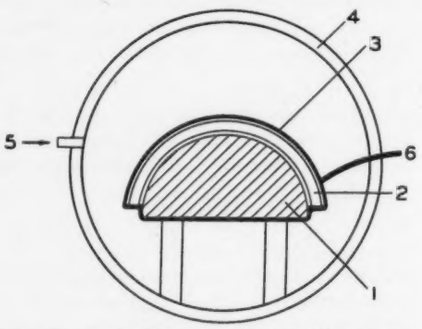
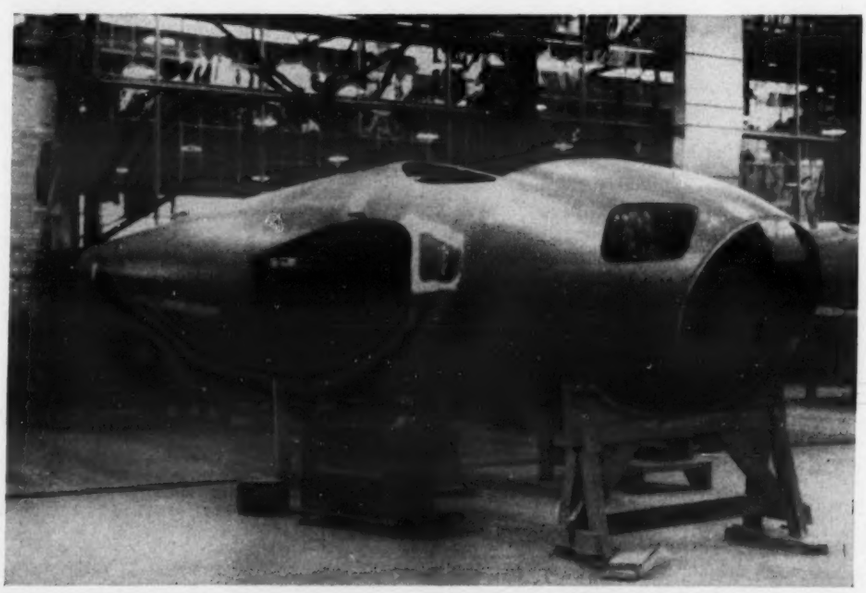


Fig. 19 : Bag molding of sandwich skin. (1) is the mold, (2) the sandwich skin, (3) the rubber bag, (4) the autoclave, (5) the inlet for steam, and (6) the outlet for air (bleeder).

Fig. 18 : Sandwich type molded fuselage of de Havilland " Mosquito ". (Courtesy of Air Trails.)



assembly is placed in an autoclave 4, which is simply a steel tank provided with heating and pumping facilities. Steam is then forced into the autoclave through inlet 5 and the air escapes from under the rubber bag through the so-called bleeder marked 6. Under the uniform fluid pressure exerted by the steam upon the sandwich skin through the bag and because of the action of the heat, the synthetic glue hardens until it has joined the various layers firmly into a solid thick sandwich skin.

New synthetic glues developed during World War II, for example Cycleweld, made it possible to glue together entirely dissimilar materials such as wood and metal. For this reason there is a variety of faces available today for the sandwich skin. Among them are aluminium alloy and stainless steel sheets, plywood, Papreg and Fiberglas textile. Papreg is a high strength paper, bonded with synthetic resin, which was developed by the U.S. Forest Products Laboratory in Madison, Wisconsin. It has a tensile strength and a specific weight both approximately half of the corresponding values for aluminium alloys. Papreg is available in sheets of 0.003 in. thickness, which can be glued together to form faces of any desired thickness. The major drawback of Papreg is its brittleness. It breaks when hit by a sharp object. Fiberglas is a thread made of extremely thin glass flock having a diameter of about 0.0003 in. Such thin filaments of glass are not brittle, they can be bent and spun into yarn. The yarn is woven into cloth and many layers of thin cloth are glued together with synthetic resins to form faces of sandwich type structural elements. The strength of Fiberglas textile is about the same as that of aluminium alloys, but the former 40 per cent less than the latter. The main advantage of Fiberglas textile is the ease with which it can be tailored into structural elements of compound curvature. Experimental aeroplane wings and fuselages were built of Fiberglas and flown successfully at the Wright Field base of the Materiel Command of the United States Army Air Forces.

The situation is not quite so satisfactory in regard to core materials since the compressive and shearing rigidities of many of the light-weight cores are too low. The low rigidity gives rise to an early buckling of the faces, denoted as ripple-type instability. This buckling was first calculated and experimentally observed by G. S. Gough, C. F. Elam and N. A. de Bruyne in 1940. Figs. 20 to 22, taken from a paper written by S. E. Mauntner and the writer, show the ripple-type buckling. These investigators observed that the faces buckled according to a pattern involving predominantly extensional deformations of the core when the core was much thicker than the face. When this was not the case the deformations were predominantly of the shearing type. The former was designated as the symmetric ripple, and the latter as the skew ripple. The critical stress corresponding to any possible ratio of core thickness to face thickness could be given with sufficient accuracy for engineering purposes by the following formula :

$$f_{cr} = (1/2)\sqrt[3]{E_f E_c G_c}$$

where E_f is Young's modulus of the face material, E_c Young's modulus of the core, and G_c the shear modulus of the core.

The interesting fact about this formula is that the buckling stress depends only upon the mechanical properties of face and core and is entirely independent of the dimensions of the various layers. Whenever the rigidity of the core is too low, the faces fall through the formation of a ripple.

The small shearing rigidity of the core may also cause unusually large deflections of a sandwich type beam subjected to a transverse load. Moreover, a sandwich type column may buckle under an unexpectedly low compressive force because of large shearing deformations. When the shearing rigidity is large, as is the case in a solid-section steel rod, the shape of the deflections at buckling involves large tensile strains on the convex side of the column and large compressive strains on the concave side. This means that the column buckles according to the bending pattern and its buckling load can be calculated from the Euler formula given in Part 1 of this article. But when the shearing rigidity of the core of a sandwich column is small, a somewhat similar deflected shape can develop without substantial tensile or compressive strains in the faces. In the limiting case the deflected shape can result from pure shearing deformations in which layers of the core perpendicular to the axis of the column slide over one another. In an actual column having a weak core a combination of the two types of deformations corresponds to the smallest buckling load which can be calculated from the Engesser formula :

$$P_{cr} = \frac{P_E GA}{P_E + GA}$$

where P_{cr} is the critical load of the sandwich column, P_E the Euler load of the same column, G the shearing rigidity of the core, and A the cross-sectional area of the core. This equation was developed by Engesser at the end of the last century, of course not for sandwich construction but for columns that are weak in shear like wooden columns. Recent investigations carried out independently by D. Williams, D.M.A. Leggett and H. G. Hopkins in England in 1941, by A. van der Neut in Holland in 1943, and by S. E. Mautner and the writer in the United States in 1946 showed that the Engesser formula gives the buckling load of a sandwich column with sufficient accuracy if the faces are thin, but a more accurate formula must be used when the faces are thick.

The, Engesser formula, however, shows clearly the basic effect of a small shearing rigidity of the core. When the product GA is equal to the Euler load P_E, then the crit-

Fig. 20 : Symmetric ripple-type failure of sandwich panel compressed edgewise. Thickness of core, 0.457 in. ; thickness of face, 0.01575 in. (From Journal of the Aeronautical Sciences.)

Fig. 21 : Skew ripple, face view. (From Journal of the Aeronautical Sciences.)

Fig. 22 : Skew ripple, edge view (enlarged) ; thickness of core, 0.233 in. ; thickness of face, 0.02025 in. (From Journal of the Aeronautical Sciences.)

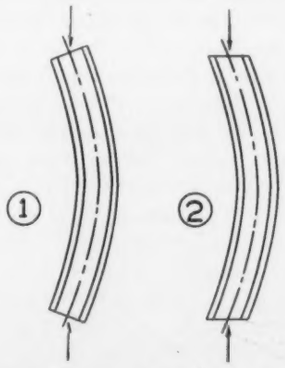


Fig. 23 : Buckling of columns. (1) Euler type in which the convex face is stretched and the concave compressed ; (2) shearing type in which the faces do not change their length and the core is sheared.

ical load of the column is exactly half the Euler load. This might easily be the case with a sandwich column using a synthetic material for the core. In the case of a solid-section metal column *GA* is likely to be equal to about 20 times the Euler load, so that then the critical load of the column does not differ from the Euler load by more than 5 per cent. The comparison emphasises the importance of developing a synthetic core material with a considerably higher shearing rigidity than any has today.

With present day face materials it appears that a core having a Young's modulus and a modulus of rigidity each over 20,000 lbs. per sq. in. would be satisfactory for all purposes. At the same time a good core material should not weigh more than 2 to 6 lbs. per cu. ft. (have a higher specific gravity than 0.032 to 0.096).

Let us now review the core materials available at present. The only one that comes close to satisfying the specification given is balsa wood. Balsa is a fast growing tropical tree indigenous to the West Indies, Central America, and northern South America. Its wood is used extensively in structural components of aeroplanes built by Chance-Vought Aircraft. In the Chance-Vought planes the balsa wood core is combined with aluminium alloy faces and the resulting structural element is known by the trade name of Metalite. It was used in the manufacture of 200 sets of stabilisers for the "Corsair," which are now undergoing service tests with the United States Navy. The XF6U-1 jet-propelled experimental fighter, announced recently by the United States Navy, is shown in Fig. 24. Approximately 95 per cent of the total structure of this aeroplane is manufactured of sandwich.

In the Chance-Vought Metalite the balsa wood core is arranged with the grain perpendicular to the faces, while in the de Havilland "Mosquito" the grain was parallel to the faces. The perpendicular grain arrangement has the advantage that it results in a Young's modulus of about 600,000 lbs. per sq. in. being effective perpendicular to the faces. This value together with a shear modulus of about 25,000 lbs. per sq. in. is better than the specification for the ideal core and consequently ripple-type instability cannot develop until the yield point stress of the face material is reached. The weight of balsa wood, however, does does not quite comply with the specification. Although a density of 6 lbs. per cu. ft. (a specific gravity of 0.096) is often found in balsa wood, it is usually restricted to small portions of the timber while the remainder may have considerably higher values. Therefore it has not been found economically feasible to use balsa wood weighing much less than 10 lbs. per cu. ft. (of a smaller specific gravity than 0.16) in series production.

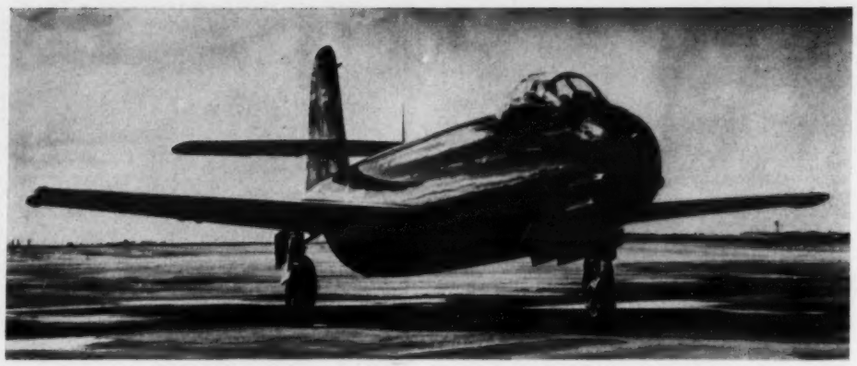
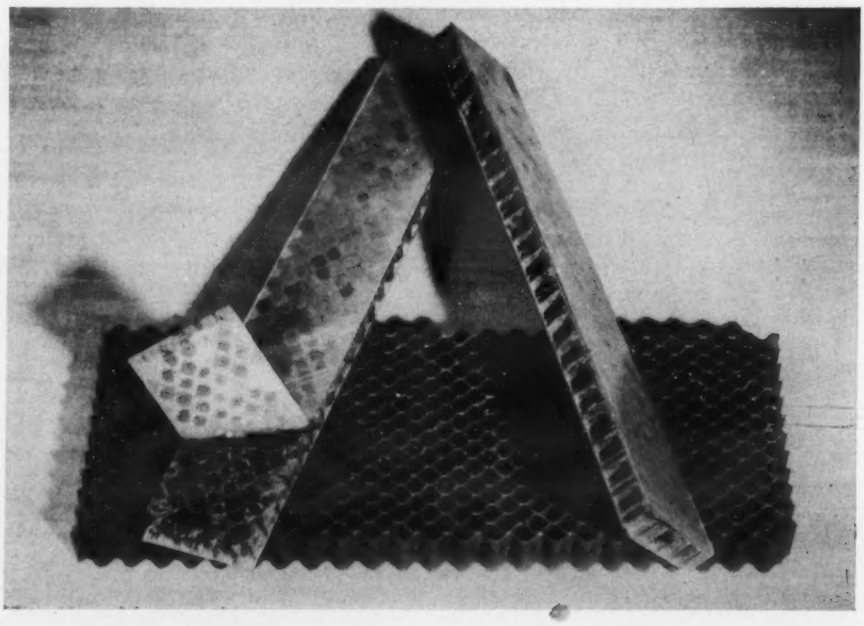


Fig. 24: Chance-Vought XF6U-1 Navy fighter. Approximately 95 per cent of the total structure of this jet-propelled aeroplane is made of sandwich. (Courtesy of Chance-Vought Aircraft.)

Chance-Vought Aircraft feels sure that balsa wood is satisfactory for aeroplane construction. Other manufacturers, however, still shy away from the use of wood and prefer to substitute a synthetic material for it. There are many plastics on the market today which can be used for the core of sandwich elements if they are in an expanded state and several procedures are known by which plastics can be expanded. In one the plastic while in the liquid state is mixed with a gas-producing agent. The mixture is then heated in an oven until the agent develops bubbles inside the plastic and the plastic hardens. In another procedure the plastic is whipped into a foam before it is hardened in the oven. In either case a considerable part of the final product consists of bubbles so that its weight is low. At present, among other substances, cellulose acetate, polystyrene and polyvinil are available in a cellular or foamy state ranging in density from 2 to 8 lbs. per cu. ft. (in specific gravity from 0.032 to 0.128). The elastic moduli of these substances, however, do not come up to the requirements of our specification.

Another approach to the solution of the core problem lies in constructing a grid and cementing it between the two faces of the sandwich skin. Experiments carried out with plywood faces connected by a latticed structure of pine were described in several British reports. In the United States The Glenn L. Martin Co. in collaboration with United States Plywood Corp. developed a structure which is called the honeycomb core. This is manufactured of resin-impregnated cotton fabric arranged in a honeycomb pattern. Rigorous tests carried out at The Glenn L. Martin plant proved the material to have suitable mechanical properties for use as a core. It was also found possible to cement it to metal faces in a satisfactory manner. However, the thin faces can

Fig. 25: Papreg honeycomb core, and sandwich made of Fiberglas faces and Papreg honeycomb core, manufactured by the U.S. Forest Products Laboratory.



buckle locally into the holes of the honeycomb and the shearing rigidity of this type of core is low enough to have an adverse effect upon the buckling load of a sandwich column.

Fig. 25 contains a photograph of a honeycomb manufactured of Papreg by the U.S. Forest Products Laboratory. The mesh of this honeycomb is unusually fine, the diameter of the holes being $^3/_{16}$ ins. The sandwich specimen in the figure has faces of Fiberglas with a core of Papreg honeycomb.

Research and development are going on intensively with the object of making better sandwich cores available to the aeroplane designer. It can be anticipated that this effort will succeed in the near future in producing cores more suitable than any of the synthetic materials now on the market. Then sandwich construction will have a real chance of general acceptance for the manufacture of high-speed aircraft.

Sandwich construction, corrugated board type skin, machined thick metal skin, and sheet covering with integral stiffeners are all attempts to find a structural arrangement that can satisfy the increasingly stringent aerodynamic requirements as the speed of the modern plane approaches the velocity of sound. It is still a question whether any of these arrangements will be generally adopted, or whether some other new solution of the design problem will replace the structural methods used today. But one thing is certain : aeroplane structures are now undergoing a development just as rapid, as full of creative imagination, and of as great importance to the future of aviation as that around 1930 when the thin-walled monocoque was introduced into aeroplane design.

Prospects of Cross-Wind Landing Gear

In recent years there has been an increasing tendency to build aircraft of greater gross weight, but without noticeably greater dimensions. Logically enough, this entails a corresponding increase in wing loading, and the resulting higher take-off and landing speeds require longer take-off and landing distances. Numerous airports are already in danger of being bypassed by the major air routes because their runways are insufficiently long. Unless considerably expanded, such airfields have to be relegated to the status of second or third-class facilities, served only by short-range aircraft.

On the other hand, the difficulty confronting airport expansion is not necessarily always of a financial nature. If it is a case of the field being surrounded by built-up areas, or of its topography rendering superficial expansion impossible, then all the money in the world will not suffice to retain trunk route trade.

Apart from prescribed runway lengths, the superficial expansion of an airport has also to contend with the fact that one single runway is more often than not inadequate. If an airport is to provide safe landing possibilities in all weathers and under all wind conditions, then it has to possess at least three or more runways, which can be arranged in parallel or tangentiai pattern. Only in this way is it possible to provide a runway parallel to the direction of the wind, whatever the direction may be. But taking the case of an airfield equipped with three runways in a triangle, it is clear that two of the strips are useless if the wind is blowing in any specific direction. If the wind keeps on changing direction, then operations have to be transferred accordingly from one runway to the other, which, besides complicating the task of the ground personnel, entails a considerable restriction in operational elasticity.

These facts have been realised for a long time, and studies have been going on for many years to eliminate these disadvantages.

If, for instance, the three or four runways of an airport could be cut down to one single runway, or two parallel strips in the case of large terminals, the result would be an appreciable lowering of the constructional and maintenance costs, and it would be far easier to expand airports to cope with future aircraft requiring longer landing and take-off distances. One means of attaining this goal was seen in the equipment of aircraft with so-called cross-wind landing gear.

The concept is not new. Serious tests with this type of landing gear were already carried out in 1938. Important firms in Great Britain and the U.S.A. are today experimenting and carrying out practical tests with a view to perfecting the cross-wind landing gear—or drift undercarriage, as it is also called—to such an extent that its application need not be confined solely to private and touring aircraft. Credit for

Airspeed " Oxford " trainer fitted with drift undercarriage, showing the additional equipment for the hydraulic castoring mechanism.

Landing gear strut of the Miles "Magister," showing gear box and torsion rod of the mechanical castoring system.

pioneering the drift undercarriage probably goes to O. F. MacLaren, a Britisher, whose system is at present being developed by Airwork, Ltd., of Heston, Middlesex. In the U.S.A. the Civil Aeronautics Administration has placed a series of contracts with various firms, including Fairchild Engine & Airplane Corp. and Goodyear Aircraft Corp., for the development of cross-wind landing gear.

The cross-wind landing gear should permit aircraft to land or take off, regardless of wind direction, without imposing side-loads on the wheels. This can be achieved provided the wheels can be swivelled or castored so as to be in line with the direction of travel on the runway. A number of undercarriage systems have already been constructed with wheels which can castor sufficiently to allow aircraft to weathervane up to 30 degrees to either side of centre, and counteract fairly strong cross winds as much as 90 degrees from runway heading.

It is obvious that the cross-wind landing gear involves something more than a minor technical improvement. It is doubtlessly a project of considerable import, for the one-runway airfield would be of inestimable value to aviation. Once satisfactory results have been obtained in tests, not only with light aircraft but also with medium and heavy transports, then the signal will have been given for a widespread utilisation of the cross-wind landing gear.

For the present, it is rather difficult to imagine a four-engined Lockheed "Constellation" equipped with this type of landing gear. A certain amount of experience has been gathered in this field, however, with numerous other types of aircraft fitted with the most varied types of cross-wind landing gear. In Great Britain, for instance, tests are being carried out with the Airspeed "Oxford" twin-engined trainer, the Miles "Magister" two-seater trainer, the Miles "Whitney Straight" single-engined monoplane, and the North American "Mustang" fighter. In the U.S.A. similar tests have been executed with the Fairchild PT-19 trainer, the Goodyear GA-2 amphibian, the Piper and North American "Navion" personal aircraft, and several others. British tests with a twin-engined de Havilland "Rapide" and similar tests with heavier type aircraft in the U.S.A. indicate clearly that serious consideration is being given to the possibility of fitting commercial aircraft with cross-wind landing gear. Northrop Aircraft Inc., for instance, builders of the Northrop N-23 "Pioneer" three-engined feeder (cf. *Interavia Review* No. 8/9, P. 67-71) will provide the CAA with all engineering data, blueprints, stress analysis and weight reports for application of a castored-wheel undercarriage to this new plane, which was selected because of its advantages in feeder airline operations. Another contract signed by the CAA is with the Goodyear Aircraft Corporation for the design and test of a castored-wheel landing gear on a Douglas DC-3.

Solution of the mechanical and operational problems occasioned by the installation of cross-wind landing gear is, of course, very much dependent upon the type of aircraft and undercarriage. From the constructional point of view the cross-wind landing gear may be regarded as already perfected. But more often than not it is the case of such landing gear being introduced as a modification of an existing design of undercarriage, which means that the space available for its installation is limited, particularly if it is to be retractable. All the same, quite a number of systems can be applied for the constructional configuration and adjusting mechanism of cross-wind landing gear, such as oleo-pneumatic, electric, or purely mechanical.

In the case of the Airspeed "Oxford," the system for swivelling the two main wheels and the tail wheel comprises a series of three hydraulic circuits, fluid pressure being provided by a hydraulic pump. The three circuits do not only provide the power necessary to pre-set the wheels, but also serve to keep the wheels in phase, three jacks used for pre-setting the two main and the tail wheels all having equal displacements. The side angle of the undercarriage is therefore not set during taxiing but prior to the take-off or landing, according to wind direction and strength. Of course, a system of this sort is not without difficulties, due, for instance, to the expansion of the hydraulic fluid under varying temperature conditions. This has been counteracted by providing recuperators in the various closed circuits. But whilst the undercarriage fitted to the "Oxford" has given many months of useful service and very little trouble, it cannot be claimed as suitable for operational conditions.

In the Miles "Magister" a purely mechanical gear has been designed, in which the main wheels are pre-set by worm and worm-wheel and the tail wheel steering cables biased by a screw jack. In contrast, the North American "Mustang" is equipped with a combined electric-hydraulic system. The result of the "Mustang" trials are extremely encouraging, take-offs and landings at 90 degrees to surface winds up to 60 m.p.h. having been carried off satisfactorily. The pilot's controls consist of three buttons. Pressing the first and third buttons moves the wheels to port and starboard, respectively, while the second button is for centralising the wheels, an operation which is indispensable if the undercarriage is retractable. For safety reasons, the wheels are automatically centralised when the undercarriage retracting lever is moved to the "Up" position, so that manual centralisation is in reality of secondary importance.

Despite its complications, this system has worked extremely well. Meanwhile, however, an undesirable feature would appear to be the burden of additional levers and instruments to the pilot. This disadvantage seems to have been overcome by Goodyear Aircraft Corporation, who have equipped their GA-2 amphibian with a retractable cross-wind gear in which the wheels castor

Airspeed "Oxford" with wheels castored at 30 degrees

freely with the landing, take-off and taxi forces of the plane, the entire castoring mechanism being contained within the wheel itself. No changes are required to the standard undercarriage equipment other than the installation of the special wheels.

Comparison of the advantages and disadvantages of cross-wind landing gear, as they are reported by the various firms at present working on the idea, enables the advantages to be summarised as follows:

1. Ability to take-off and land at any angle to wind;
2. Airfields with one single but sufficiently long runway are completely operative regardless of wind direction;
3. Capital and maintenance costs of a one-runway airport are about half of those of a multi-track terminal and traffic control is greatly simplified;
4. A greater number of existing airports could easily be developed to meet present demands;
5. Less wear and tear on tyres and undercarriage because of reduced side-loads.

Against all these advantages is the increase in weight due to the cross-wind landing gear. According to Airwork Ltd., this is unlikely to exceed about one per cent. and may be substantially less in the case of heavy types of aircraft. In any case it is impossible to establish standards in this connection, as the principle involves so many different systems. The nose-wheel undercarriage weighs about two per cent. more than the tail-wheel type. If fitted with castoring wheels, it will increase in weight by about three per cent. Although such an installation involves no great structural difficulties, the increase in weight makes the use of castored wheels with tricycle undercarriages less advisable.

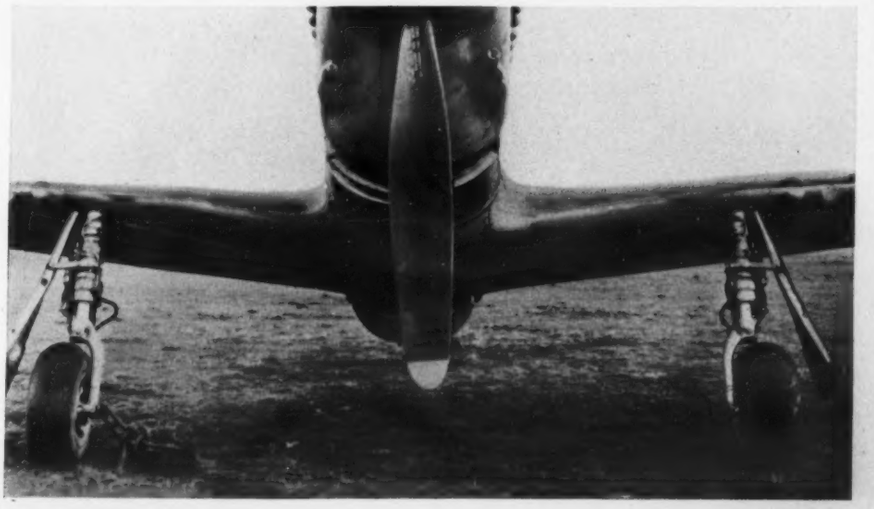
Cross-wind landing gear with freely castoring wheels, built by Goodyear and fitted to the GA-2 amphibian.

It is clear from the above paragraphs that the advantages offered by the cross-wind landing gear are not to be underestimated, particularly in the case of light planes. Operations would become independent of wind conditions, and the lower costs in airport maintenance would not only be to the advantage of the airport administration, but also to the private pilot. But the utility of the cross-wind landing gear in civil aviation is also well imaginable. In remote regions of low traffic density, but where there is a lack of surface transportation, large airfields are usually not worth while erecting. The result is that they have only one runway, which means that operations are very much contingent upon wind conditions. In such an instance, the advantage of the cross-wind landing gear over the nose-wheel or tail-wheel undercarriage is obvious.

A long way will still have to be travelled before heavy transports can be fitted with cross-wind landing gear. Above all, more experience will have to be gained in cross-wind take-offs as well as landings.

(Left) Aircraft fitted with normal undercarriage has to land at an unfavourable angle if there is a strong cross wind. This imposes detrimental side-loads on the landing wheels and often results in a ground loop because the wheels are not in line with the direction of travel on the runway. (Right) Cross-wind landing of aircraft equipped with drift undercarriage. In the system shown, the wheels are not pre-set, but automatically fall in line with the direction of travel.

Electric-hydraulic castoring and retractable undercarriage of the North American "Mustang" fighter.



Notwithstanding the difficulties which are currently being encountered in the constructional execution of the idea and the operation of cross-wind landing gear, there is every reason to believe that its prospects warrant the expense and trouble involved.

Ba.

BOEING BUILDS GAS TURBINES

The development and construction of an aircraft, particularly of a large transport type, as a rule requires a period of several years. In order that the design engineer may keep this time as short as possible, it is essential that he be provided with the most complete data available on every aspect of the project. If the customer has to be supplied in advance with guarantees of the minimum performance of a new design, it is most important that the aircraft firm be in possession of precise details on the power plant to be fitted.

The continual desire for increased speeds is bringing about the replacement of the reciprocating engine, already developed to its maximum, by jet-propulsion and propeller-turbine engines. Already in 1943 the U.S. Army Air Forces began to show a lively interest in the use of the then new and untried gas turbines in large aircraft, a type in which Boeing Aircraft Co. had specialised.

Fig. 1: Sample disc of new turbine alloy being tested in spin-pit at 100,000 r.p.m.

Realising that it would have to contribute its share towards the development of large jet-propelled planes, Boeing was destined to find that what data were available on gas-turbines for aircraft were for the most part conflicting. No two manufacturers or laboratories could agree on the fuel consumption, life expectancy, safe operating temperatures or maximum pounds of thrust or shaft horsepower possible with the new power plants.

Pioneers in the practical application of the exhaust supercharger to military aircraft, Boeing's contributions to the science of propulsion can be traced back to 1925. It was therefore only normal that the firm should find its place in the new era in aircraft power plants, brought about by the advent of gas turbines and jets. In consequence, Boeing decided to set up its own research programme to seek the information which was not forthcoming from other sources. The first step was the establishment of a complete preliminary design project, aiming towards the critical evaluation of all data on turbines. In June, 1943, an active study into jet propulsion was inaugurated, the original intention being to conduct a pure research project and not to develop any specific type of power plant for manufacture. Thus, various turbine components were actually built, such as compressors, turbines, gear boxes and accessories, for the purpose of evaluating each separately and discovering its potentialities. Axial-flow and centrifugal compressors were built and complicated test and research equipment set up for a complete study programme. The company's engineers realised that they could not design a successful jet-propelled aeroplane unless they had full knowledge of what problems were involved in installing, operating and maintaining the new type of power plant.

This was carried out in the propulsion research laboratory at Boeing's Seattle plant, which includes six test cells, two machine shops, and an assembly and testing area. There are also metallurgical laboratories, and a battery of research instruments includes optical pyrometers, metal spin-testing pits, elaborate manometer boards and automatic cameras for recording results of test runs. Fig. 1 shows a spin-pit in which

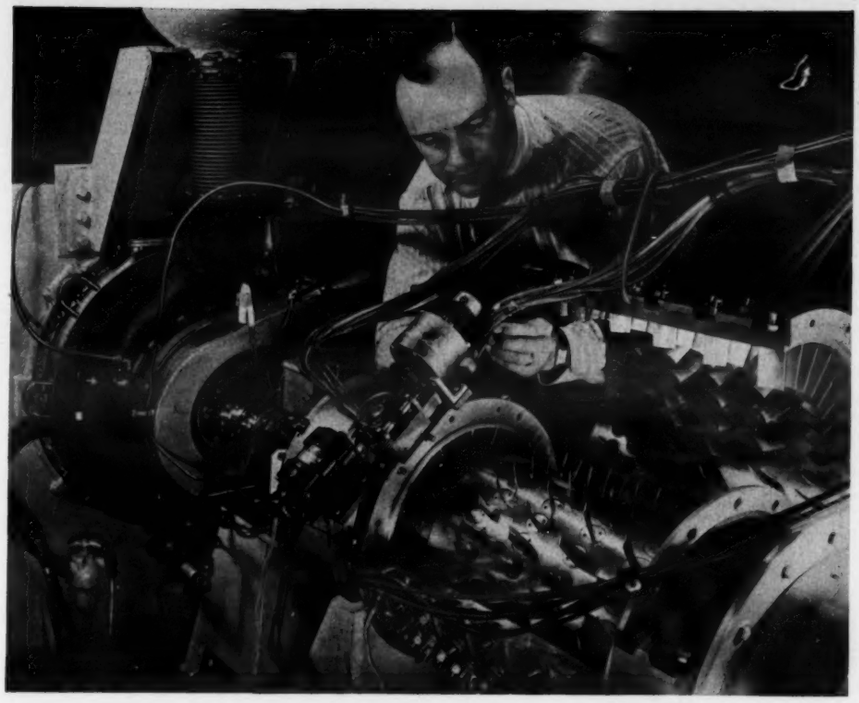


Fig. 2 : Axial compressor with interchangeable rotor and stator blades, used by Boeing for evaluating different blade sets.

a small metal sample disc is being spun at speeds up to 100,000 r.p.m. until a failure cocurs. As can be seen from the photo, an uatomatic camera records the results.

Interestingly, General Electric turbosuper-chargers, formerly used on the B-17 " Flying Fortress, " are utilised for supplying high-pressure air for testing. Steam under fifty pounds pressure is fed into the B-17 turbo and turns its compressor to furnish high velocity air for test purposes. In addition, steam-driven turbos are used to drive experimental compressors, as can be seen from Fig. 2. The research programme included thorough tests with axial-flow and centrifugal compressors, and trials were even carried out with a four-stage axial-flow compressor with adjustable rotor and stator blades at high air velocities. This particular compressor permitted various types of blade sets to be investigated systematically at speeds up to 16,000 r.p.m.

Design studies progressed to such a point and the gas turbine became so promising that two complete power plants were actually built. The first of these is the *Boeing Model 500*, a midget jet engine. Structurally, it scarcely differs from conventional larger versions. It comprises a single-stage, single-sided radial compressor directly coupled to a single-stage gas turbine with the turbine wheel arranged centrifugally. Instead of having a large number of combustion chambers, the Model 500 has only two, which connect the compressor and turbine casings. To save space, the auxiliaries are positioned above the shaft casing between the compressor and turbine. Weighing only 85 lbs. and operating at 1,500 deg. F., this midget turbo-jet delivers 150 lbs. of thrust. Despite its unusually high operating speed of 36,000 r.p.m., no serious design fault has developed to date. The prototype has already undergone over 100 hours running time and more than 1,000 hours have been run on components. Its simplicity and light weight make it one of the most efficient thrust-per-pound (0.567) engines in existence today.

It is evident that the Model 500 will find a wide field of application. Boeing foresees its use as a starter engine for jet units or turbines, or as a thrust source for missiles, glide bombs or small aeroplanes.

Boeing has since gone a step further and developed a propeller turbine from the

Fig. 3: Boeing Model 500 midget jet engine.

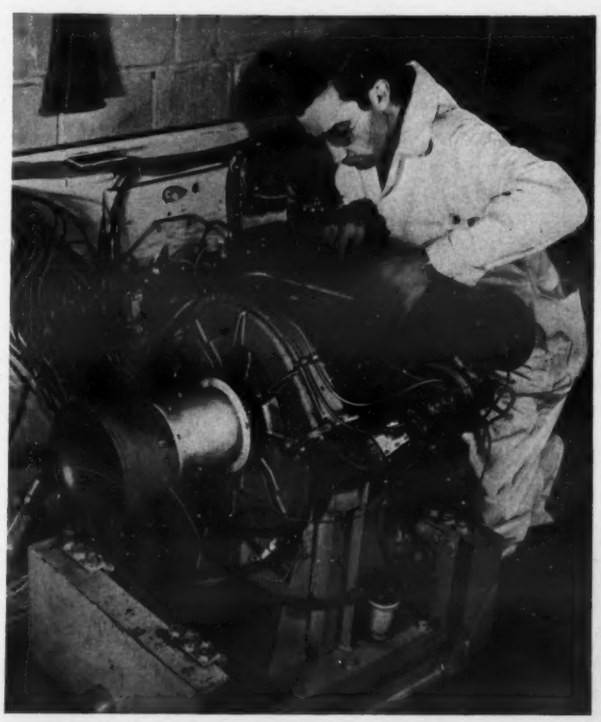


Fig. 4: Single-stage compressor and single-stage turbine of Model 500 are connected by a common shaft.

Fig. 5: Showing the engine's small dimensions.

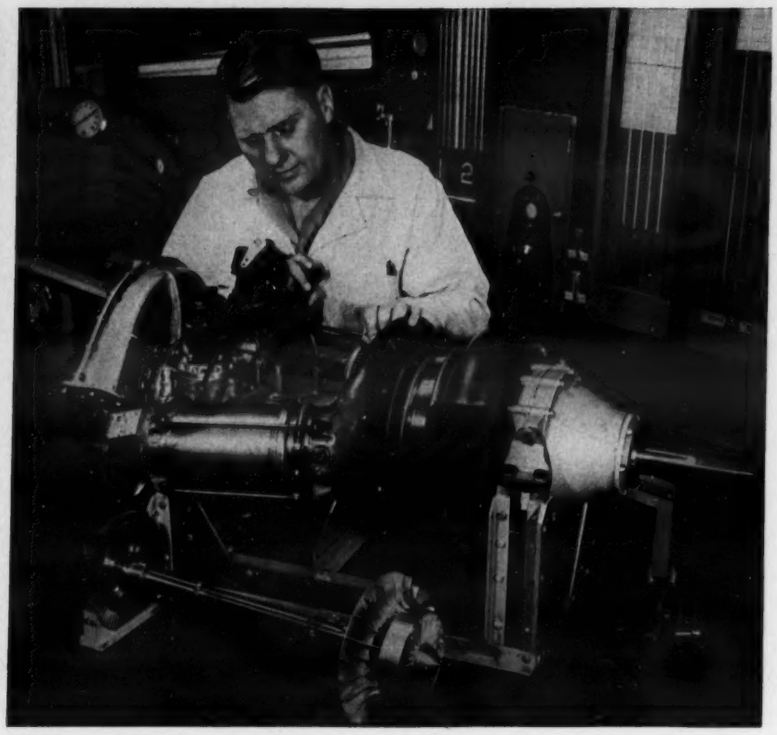


Fig. 6: Model 502 propeller turbine, weighing only 140 lbs.

Model 500. Known as the *Boeing Model 502*, it utilises most of the basic parts of the Model 500, but has an additional, separately-encased turbine wheel turning the propeller shaft through a gear box (see Fig. 6). The exhaust gases are expelled from the additional turbine wheel casing through side openings. Though this configuration seems to be extremely advantageous for driving pusher airscrews, it looks as though certain difficulties might be encountered with tractor airscrews, notably as regards leading the air to the compressor. The prototype was recently completed and has already undergone its initial bench runs. It is interesting to note that additional experimental power plants of this type will be built for the military services.

In addition to developing 200 shaft horsepower, the Model 502 also exerts 50 lbs. of thrust. It weighs 140 lbs., from which may be calculated its commendably low specific weight, 0.70 lb./H.P. (calculated from shaft output). This compares with a weight of approximately 500 lbs. for a 90-H.P. motor-car engine. This midget turbo-prop unit appears suited for use in both small aeroplanes as the prime power source, and in larger aircraft as an auxiliary power plant. Other uses which it may find include boats, target planes, and perhaps with further development, in automobiles and stationary power plants.

Fig. 7: Test bench at Boeing's ram-jet research laboratory.

Specifications

Boeing 500

Length	29 ins.
Maximum diameter	22 ins.
Diameter of turbine wheel	7½ ins.
Total weight	85 lbs.
Maximum thrust	150 lbs.
Normal operating speed	36,000 r.p.m.
Thrust/Weight ratio	0.567

Boeing 502

Length	42 ins.
Maximum diameter	22 ins.
Weight	140 lbs.
Shaft output	200 H.P.
Additional exhaust thrust at this output	50 lbs.
Specific weight, calculated on shaft output	0.70 lb./H.P.

In conclusion, it may be mentioned that, late in 1946, Boeing Aircraft Co. built a new and completely separate ram-jet research facility at Renton, Washington, close to the wartime "Superfortress" plant. Here, in a still restricted Army programme, ram-jet studies are under way.

Some French Aircraft Types now in Production

C. 800 GLIDER
Two-seater trainer.

NORD 1200 "NORÉCRIN"
Three-seater personal aeroplane.

BREGUET 11E HELICOPTER

MORANE-SAULNIER 472
Two-seater fighter trainer.

SUC 10 "COURLIS"
Taxi or personal aircraft.

SO 7010
Taxi or light transport aircraft.

NC 702
Eight-passenger transport aeroplane.

SO 30 R
Modern 30-passenger airliner.

LANGUEDOC 161
Four-engined 33-passenger airliner.

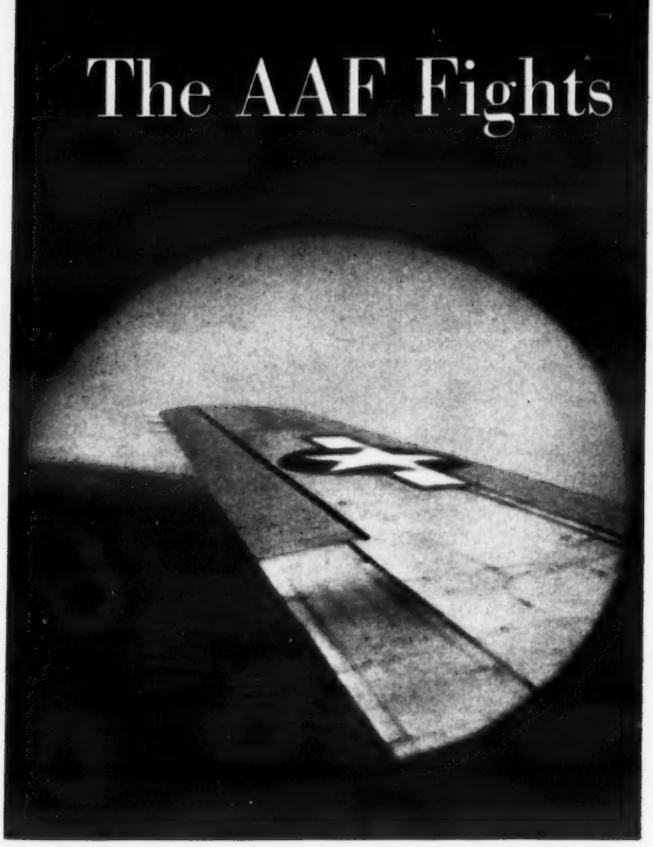
LATÉCOÈRE 631
72-ton flying-boat.

OFEMA

OFFICE FRANÇAIS D'EXPORTATION DE MATÉRIEL AÉRONAUTIQUE

4, RUE GALILÉE - PARIS 16e
TELEPHONE: KLÉBER 89-10 TO 89-19
TELEGRAMS: EXAERO - PARIS

The AAF Fights the Weather



In this story on the War with the World's Weather, the author, veteran of a number of combat missions over Germany with the U. S. Army's Eighth Air Force, describes a trip he made with "Operation Stork," the regular meteorological flights carried out by the U. S. A. A. F. from California over the turbulent North Pacific to Alaska in order to obtain precise meteorological data. These flights are the responsibility of the 59th Reconnaissance Squadron (Very Long Range, Weather) which, operating specially equipped Boeing B-29 "Superfortress" heavy bombers, forms part of the organisation of the Weather Service of the U.S.A.A.F.

The Air Weather Service, as it is generally known to-day, emerged from very small beginnings. By the end of 1942, it had grown to be a world-wide organisation furnishing information for air transport, flight training, strategic and tactical air operations and military planning. From 40 weather stations manned by 21 officers and 167 enlisted men in July 1937, the Air Corps Weather Service grew to include 69 weather stations in July 1941, 141 stations in 1942, 274 in July 1942, 669 in July 1943, 878 in July 1944, 900 in early 1945 and 857 stations on V-J Day. By 1945, 610 of these stations were located outside the Continental U. S. in some 58 countries. Meanwhile, personnel strength had increased from the 1937 handful of officers and men to approximately 2,650 at the time of Pearl Harbour and to a peak strength of 19,000 officers and men in the summer of 1944. By V-J day, demobilisation and discharges had reduced this figure to approximately 17,800. The present authorised strength of the Air Weather Service is 9,509, of whom 2,231 would be officers.

Developments and expansion of AAF Weather Service

Brigadier-General Donald N. Yates, Commanding General of the A. A. F. Weather Service.

BY LIEUTNANT ARTHUR SHAY, NEW YORK

Below, the cold Northern Pacific was visible through the fog for seconds at a time. Standing behind the pilot and co-pilot, feeling ashamed of being only a passenger, I could tell that the going was tough, that it was difficult to hold our B-29 at its flight plan altitude of 500 feet. We had flown a hundred miles at this altitude and would fly a thousand more before climbing to 10,000 feet.

We burst into a rainstorm. The din was as if a monster with a hundred fingers was scratching the back of our "Superfort," nicknamed the "Iron Bird." There were several minutes of violent turbulence, but just as suddenly, we broke out into the clear, and the ocean looked warm and green, the sky affecting a friendly blue with detached cumulus clouds floating high above us.

The weather man in the nose compartment turned around for the first time since we had taken off from Fairfield-Suisun Airfield in California, for our flight to Alaska. "Just as I thought," he said with a smile, looking at the calculations he had completed. "It's going to rain in California tomorrow, in Denver Tuesday, in Washington, D. C., next Saturday, with probable showers in Bermuda Monday morning. The boys flying east are going to have tail winds, but the boys flying west . . ." The weather observer shrugged his shoulders and winked in sympathy with the "Boys flying west." Over the intercom he said something to one of the two Navigators, who immediately took a Loran radar fix, pinpointing the weather we had flown through. Forward visibility seemed to be unlimited, but we had been briefed to expect a cold front halfway along our 2,400 mile northwest course to Elmendorf Field, near Anchorage, Alaska.

* * *

So, with the war long over, at 500 feet over the treacherous North Pacific, we were flying another combat mission—flying it against a powerful foe, and flying it with men whose squadron had recently completed 200 long range, over-water missions in the world's worst weather area *without the loss of a single aircraft*.

I reflected that Mark Twain, the American humourist, was wrong when he said, "Everybody talks about the weather, but no one seems to do anything about it." The weather observer, busy among his instruments, was doing something about it. Indeed, the Air Weather Service of the United States Army Air Forces is doing something about the weather every day of the flying year and in almost every corner of the globe.

From the Washington headquarters of Brigadier-General Donald Yates, Commanding General of the U. S. A. A. F. Air Weather Service, the Service directs the activities of its far-flung continental and foreign weather outposts. This direction assures the short range and long range aircraft of the AAF the best available route weather information at all times. From bases like Adak (Aleutians), Kodiak (Alaska) and Ikateq (Greenland) to Waller Field (Trinidad) and Nichols Field (Manila), daily reports of the atmosphere's moods and local behaviour stream into the Pentagon Building, Washington, the seat of the U. S. War Department, where world-embracing synoptic weather charts are prepared, which enable weather experts to predict thunderstorms, warm and cold frontal areas, and even—as has been done several

have required that new equipment be designed and manufactured to meet AAF requirements for exact and extensive weather information. Standard weather instruments used in 1937 were not designed specifically for Air Corps needs. In addition, advances in meteorology and special requirements of new climatic zones of operation meant that new equipment had to be developed. New and improved airborne instruments for weather reconnaissance, portable but complete sets of weather equipment for difficult combat conditions, fully equipped mobile weather stations able to move from place to place as needed without disrupting service to using agencies and improved equipment for upper air observations—notably improved radiosondes, electronic wind-finding apparatus, and modifications to Radar storm detection sets—were but a few of many weather equipment projects initiated by AAF.

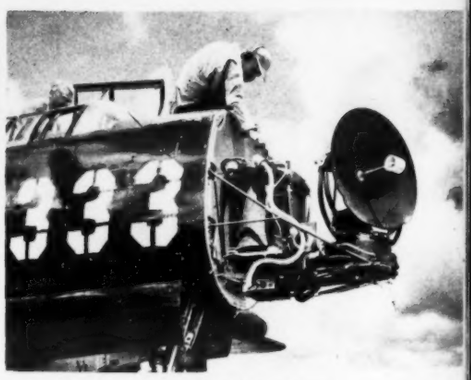
The advent of very long-range aircraft and various types of guided missile have multiplied the tasks of the Air Weather service. This fact is illustrated by the establishment at the AAF Guided Missiles Proving Ground at White Sands, New Mexico, of a special weather station primarily concerned with meteorological conditions of the upper air regions rather than weather close to the earth's surface which affects normal air traffic. The station uses the latest radar and electronic weather detecting equipment. One of the mainstays of this service consists of large neoprene balloons carrying delicate instruments to about 100,000 ft., including ground radio receivers, direction-finding equipment, and surveillance radar units to correlate weather conditions at extreme altitudes. At White Sands this information is needed chiefly for the rocket-firing programme now in progress. Before each firing, four forecasts are required : a 72-hour forecast to enable final plans to be made and supplies to be set up ; a 48-hour forecast determines if it is advisable to take the assembled rocket to the launching site ; a 24-hour forecast to decide upon the rate of installation of instruments and the advisability to continue with the programme ; a 4-hour forecast determines the practicability of fuelling the rocket for the firing.

The A. A. F. Weather Service does not rest on its laurels, but is constantly enlarging its activities. At the end of June its Commanding General announced that daily weather flights to the North Pole were expected to begin by the end of July. These flights—a few years ago they would have been considered an impossibility—will fill one of the largest gaps in world-wide weather forecasting. The flights will be made by specially equipped Boeing B-29 "Superfortresses."

As a result of the increasing use of ground and airborne radar for weather detecting and reporting, the AAF's weather officers will consist of the Army's most highly skilled technicians who are both qualified meteorologists and radar experts. To cope with the growing complexity of training its personnel, the Weather Service has established special weather schools at Chanute Field, Ill., and Scott Field, Ill. ; furthermore, contracts for training have been awarded to several universities, including the famous Massachusetts Institute of Technology and California Institute of Technology.

Today, the AAF Weather Service is commanded by Brigadier-General Donald Yates, the short, dynamic officer who in 1944, then a Colonel, was responsible to General Eisenhower for the choice of the original June 5th-6th date for the invasion of Europe, a choice made on the basis of weather expected along the Normandy Coast.

P. A. B.



Twice daily a radiosonde balloon carrying a radio transmitter is sent aloft from A. A. F. Weather Stations all over the U. S. A. to transmit by radio code the pressure, relative humidity and temperature at various altitudes. The radar equipment in the background enables the balloon to be tracked from the ground.

A radar antenna in the nose of a weather aircraft is inspected by the ground crew.

---

times in Florida—hurricanes and their courses.

In addition to the ground workers, helping to funnel the vital facts of world weather to the Air Weather Service, are squadrons of new, long-range, radar-equipped weather planes, whose job it is to plunge their plexiglass noses into storms and other dirty weather, searching always for information leading to safer flying for the Air Force. Some of the Weather Observer's weapons against his powerful enemy are garden variety — altimeters, radar, thermometers. Others are complicated and some of them secret. Since the Weather Observer's job is to obtain an over-all picture of the weather he flies through, he is primarily a fact-gatherer. He measures the cloud heights, analysing their form and structure. He computes wind direction and wind velocity. He observes the condition of the sea's surface, judging the height of sea-swell.

Before the take-off from the air base in California one of the "airplane drivers" checks the map from the previous day's mission. Map for the next flight will depend upon these observations.

The Air Weather Service's "Iron Bird," a combat-equipped Boeing B-29 "Superfortress," is readied for its weather mission.

Careful inspection of the "Iron Bird's" tail de-icer boot.

The "Iron Bird's" tires are checked and inflated.

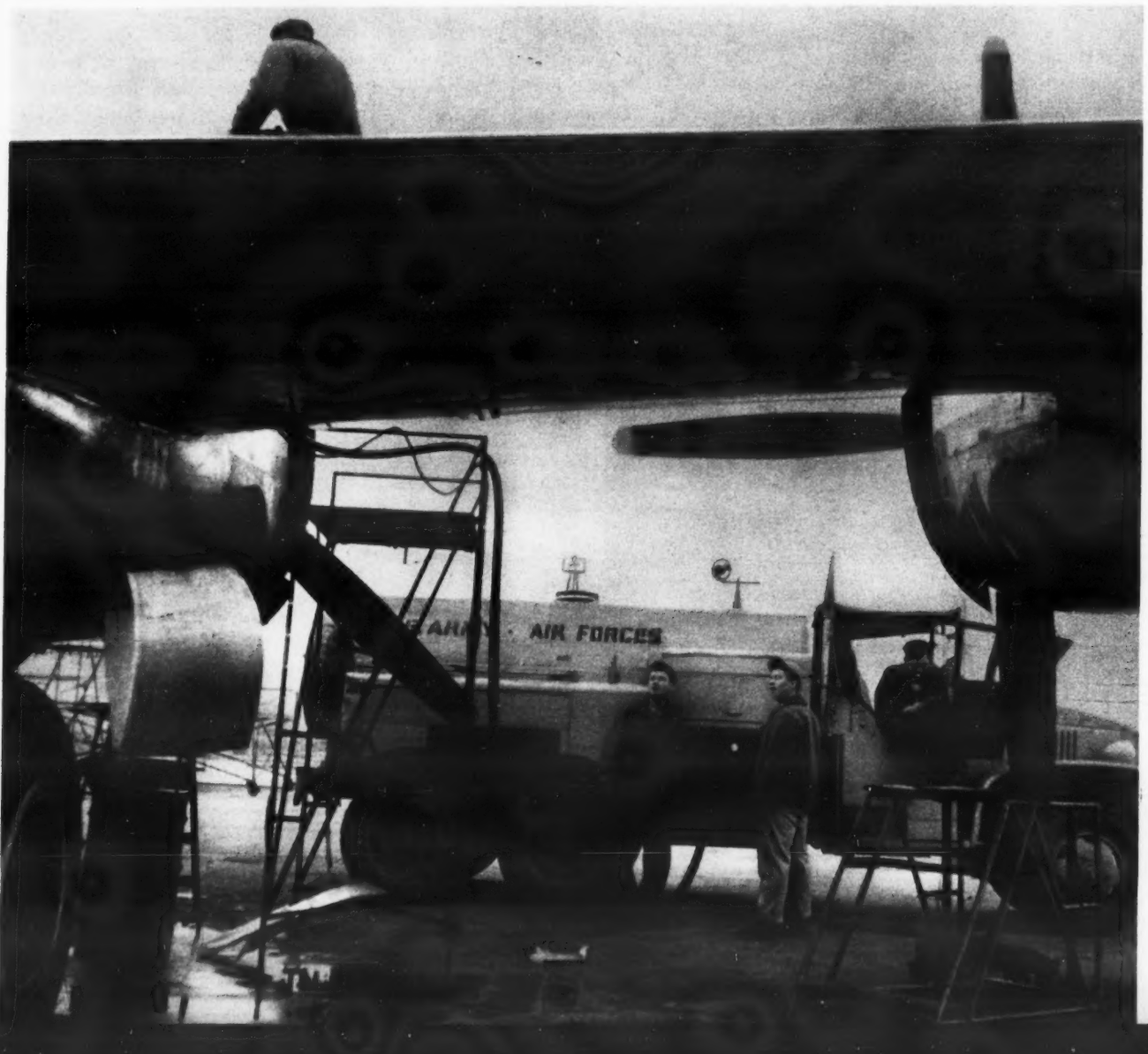
In the briefing given us in California for the "Operation Stork" mission to Alaska, it was explained that the primary reason for flying 1,100 miles of the flight at 500 feet was the necessity for the Weather Observer to compute the sea-level pressure and the exact height of standard pressure level. Additionally, the weather man notes the degree of visibility, records the dewpoint, relative length of duration of aircraft icing, altitude of icing, pressures at any specific altitude, and radar disturbances.

Most important, the Weather Observer must report the exact geographical position of any weather front encountered, and radio whatever he can determine of its nature, its severity and its course. When the Weather Observer and the navigator have completed a "weather position report," the Radio Operator takes over. Key man in the vital circuit, his job is to flash "Operation Stork" reports to the West Coast of the United States and Canada.

The total of these observations is carefully computed, even before the observation plane lands. The sum is weighed and analysed by the airborne Observer, and the final product is a hard-won, valuable extract.

In addition to the AAF, the Navy, Coast Guard, CAA, Weather Bureau and the airlines receive "Stork" reports, and relay them across the country, and where necessary, around the world. In the labyrinthian Pentagon in Washington, D. C., the Air Weather Service's Master Analysis Central plots on a world prognostication the flight observations made by the B-29 weather plane en route to Alaska. "Stork" information, coming as it does from the Alaskan Weather source region, turns an invaluable spotlight on weather to be expected in the United States, since, for the most part, North American weather moves across the Continent from Northwest to Southeast.

* * *



The weather aircraft is fuelled. With increasing size of aircraft, the operation becomes more and more tedious.

We had passed through the front. It was further along course than we expected, but not as severe. This information was flashed ahead to Alaska and back to California. We had bumped along a thousand miles and were preparing to climb through weather 4,500 miles away from weather headquarters in Washington, D. C. Ten weather observations had been made and transmitted since we left California, with the mission not yet half over.

I went back to speak with the Scanners. One of them had "scanned" twenty Stork missions, the other six. They felt neither warm nor cool about their job. Their job : To sit at a waist window for fourteen hours and watch the rear of the "Iron Bird's" engines. If oil leaks or fire starts, their job is to call the pilot on intercom and tell him. That is "scanning !"

In addition to their strategic services during the war, the AWS provided, as it does now, trans-oceanic weather-briefing for bombers and transports alike. The amazingly low weather loss of aircraft during the thousands of separate wartime ferrying operations is a testimonial to the efficacy of the Air Weather Service.

* * *

When the celebrated B-29 "Pacusan Dreamboat" lumbered down a runway on Oahu in the Hawaiian Islands, on October 4th, 1946, crossed the Arctic wastes, then Europe in its great circle course, it touched land again 39½ hours later at Cairo, Egypt, nearly 10,000 miles away. That was the outwardly simple story. But it had taken nearly two months for the weather to dispose favourably for the proposed over-the-pole flight, which had taken off on the basis of a forecast beamed to Hawaii by the AWS Master Analysis Central in Washington, a few hours before the take-off.

The crew prepares to take off.

In flight. Navigators alternate on the radar set. The B-29 is crowded, a notoriously uncomfortable aircraft. The gun turret, right, cramps the crew in the navigator's compartment.

Alaska : with the sun sinking rapidly, a precious view of Kodiak is obtained. An hour later, at 4 p. m., a night landing was made at Anchorage.

Elmendorf Field, near Anchorage, Alaska: another B-29 prepares to take off for its flight back to California.

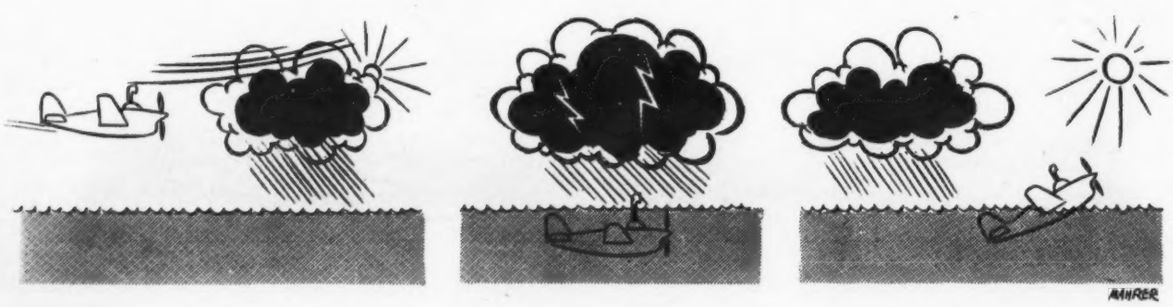
To illustrate the intensity of weather preparation for the "Pacusan Dreamboat's" experimental flight, the weather man showed me a report he had saved. It was a "first leg forecast" teletyped from the Pentagon to Hawaii:

"*Hickam Field, Hawaii, to Juneau, Alaska* . . . The frontal system in the Pacific will be of moderate intensity except for the warm front, which will be weak. This means that heavy frontal cloud will not spread far ahead of the occlusion, 5/10 cumulus, base 2,000 feet, top 4,000 - 6,000, cumulus decreasing to 2/10 north of 30 degrees North Latitude. North of 37 degrees North Latitude, low cloud will become 7/10 scattered, base 2,000, top 5,000, increasing further to 10/10 at 41 degrees North Latitude . . . Intermittent light rain 46-51 degrees N. L. . . . In rain there will be scattered to broken scud between 5,000-8,000 feet . . . Upper cloud will break rapidly, low cloud breaking slowly, becoming 7/10 scattered, base 2,000 top 5,000, then 6/10 altocumulus, base 9,000, top 11,000. Also 7/10 cirrus, base 24,000 or higher at 55 degrees N. L. and at Juneau . . . 4/10 scattered, base 2,000 top 4,000 . . . Ice in clouds above 9,000, lowering to 7,000 North of 53 degrees North Latitude." This was only the Air Weather Service's *first leg report!*

A similar forecast was transmitted to the "Dreamboat" on every leg of its long flight, and the accuracy of the Air Weather Service's predictions was marred by only three small inaccuracies.

We made landfall near Kodiak, Alaska, and it began to get dark. It was three in the afternoon, Alaskan time. We would land at Elmendorf Field, near Anchorage, in complete darkness. The Weather Observer made his last observations, reporting icing at flight level over the Alaskan mountains, and Elmendorf's weather man reported 400 feet visibility.

We'd stay in Alaska for a day, suffering ten below zero (F) weather. Another Air Weather Service plane such as the "Iron Bird" would come up from California. Then we'd fly another 14-hour mission against flying's perennially dangerous foe . . . Weather.



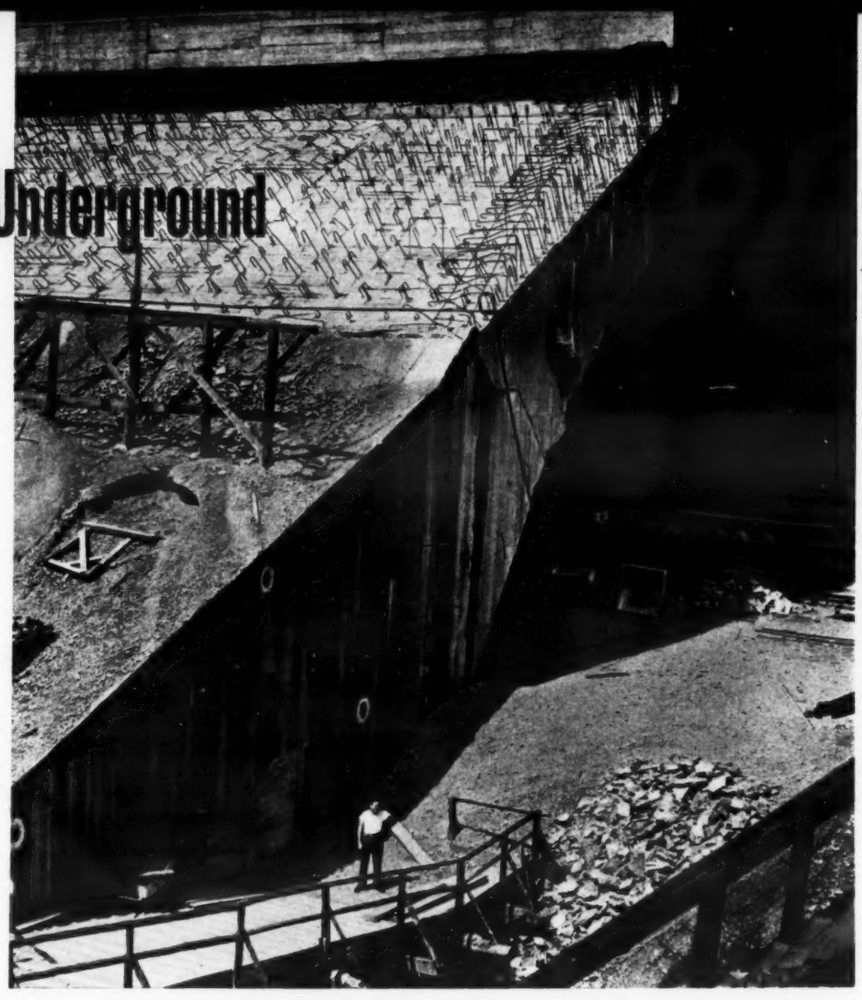
Building Aircraft Underground

One of the principal recommendations, recently submitted by President Truman's Advisory Commission on Universal Training charged with the elaboration of a programme to prepare the United States for a possible atomic war, was the construction of new, vital war plants underground. The U. S. Army, however, had previously started inspecting potential sites in disused quarries, mines and natural caves.

Evidence collected in Germany and Japan, thoroughly studied and analysed at Army Air Forces Headquarters in Washington and Air Materiel Command Headquarters at Wright Field, Dayton, Ohio, confirmed the AAF in its belief that complete underground structures represent the most practical available protection against air attack.

The Germans had been experimenting with underground structures as long ago as 1916, when they started to build underground storage installations at Baden, near Hamburg. The first complete German underground factory on record was a precision instrument plant installed in caves at Mulhausen, Thuringia, early in 1917. Interest in such structures was revived in 1935, but full-scale underground construction was started only in 1943 after the start of the Allied all-out air attacks. Hitler then ordered an organized effort to move aircraft factories—and notably the development and production of his pet projects, the V-1 and V-2 bombs—underground. By the end of the war the Germans had a total of 143 completely underground factories in production, apart from semi-underground structures. About 20 percent of the entire capacity of the airframe industry, including virtually all the V-weapons and most of the jet-fighter production, as well as nearly 60 per cent of aircraft engine production had been placed underground. Impressive as this achievement may appear, the Nazis never completed their extensive underground programme. This was due to the disrupted conditions under which they were working, to the lack of time and the failure to formulate realistic plans.

The best-known *semi-underground installations* were the submarine pens and submarine assembly plants with concrete roofs ranging in thickness from 11 to 14 ft. 9 in. Not until the latter part of the war bombs capable of damaging these structures were developed by the Allied Air Forces, and by that time the Germans were already planning to increase this thickness first to 23 ft. and later to 32 ft. 9 in.

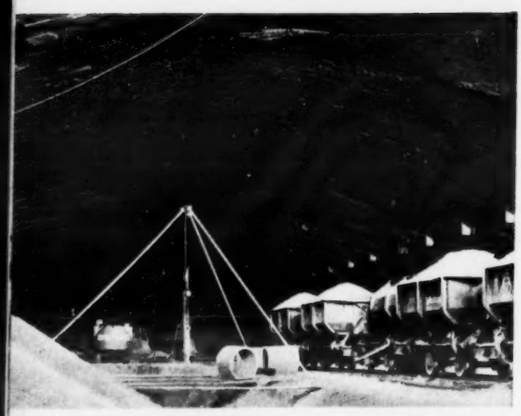


Entrance to "Bunkerwerk," or semi-underground factory at Mühldorf, in Upper Bavaria.

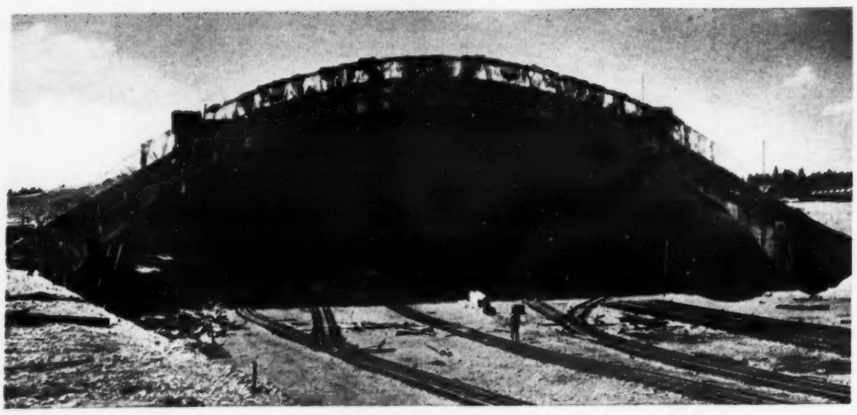
Another example of semi-underground installations were the so-called *Bunkerwerke*—"pill-box factories"—which allowed manufacturing operations with comparative freedom from bombing attacks. They were great dome-shaped structures with convex concrete roofs 9 ft. to 18 ft. thick, about 80 ft. high, and including four to six storeys with approximately 1,200,000 sq. ft. of floor space, 40 per cent of which was underground. Plans for 12 of these *Bunkerwerke* were formulated during the war, work on four of them was actually initiated, and the Landsburg aircraft factory in Bavaria was approximately three-quarters completed.

Completely underground factories were mostly built into the sides of hills or mountains, as they permitted easier installation of sewer systems and facilitated the introduction of supplies and equipment. Some of them were exceedingly complex: the plant at Kematen, near Innsbruck in Austria, which produced ailerons and flaps for the Messerschmitt Me 262 twin-jet fighter, consisted of eight tunnels

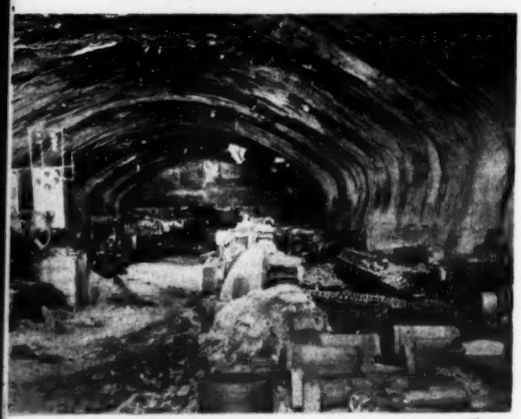
Side view of factory at Mühldorf, showing concrete layers of roof.



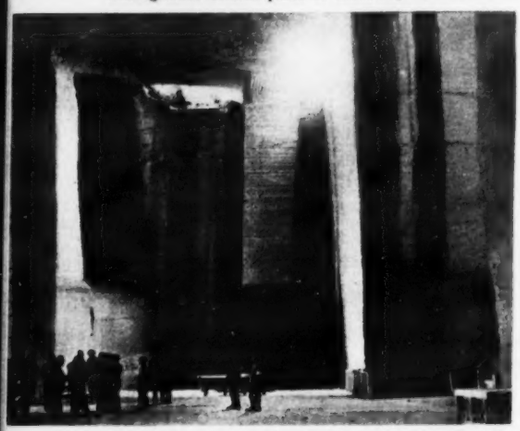
Interior of Mühldorf factory, one of twelve "Bunkerwerke" projected. None were completed.



Mouth of semi-underground factory at Mühldorf. Rails were used for carts carrying cement.



Underground aircraft plant at Hiro, Japan, near Kure.



Cavern in underground aircraft factory installed in quarry near Oya, Japan.

Parts awaiting assembly in underground aircraft factory at Oya, Japan.

and cross-passages. The plants at Niedersachswerfen, in the Harz Mountains, was the largest and most ambitious underground facility in the world and manufactured V-1 and V-2 projectiles, aircraft rockets and parts for engines and rocket bombs. It was situated beneath a steep, heavily wooded hill and its main tunnels were approximately 30 ft. wide and 24 to 30 ft. high with nearly vertical walls and vaulted ceilings. One tunnel was 75 ft. high and was used for electrical tests of the V-2 rocket. — Other examples of complete underground structures were the large converted mine at Kahla, the highway tunnels at Leonberg and Eschenlohe, several granite quarries, as well as a 2,200-ft. unfinished tunnel in the outskirts of Berlin.

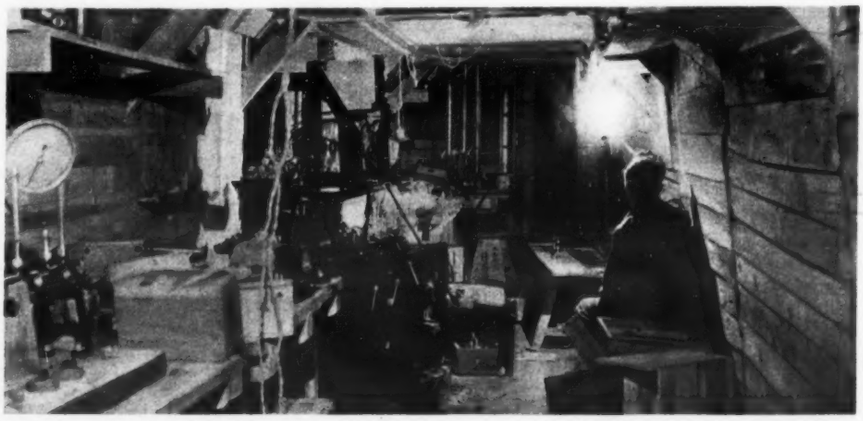
The *Japanese*, too, achieved remarkable results in the preparation of underground facilities. At Otome a plant consisted of 12 parallel tunnels through a hill and open at both ends. The Nakajima aircraft factory at Ota, damaged in an air raid, was dispersed into a number of stone quarries in the area of Oya. Quarries varying from a few thousand to 98,000 sq. ft. floor space were widely used by the Japanese. The actual floor space used in 19 plants was more than 196,000 square feet, and additional space was proposed to bring this area to 647,600 square feet. Again, the underground facilities were used chiefly for aircraft production. In some cases outside transportation was not available, and completed fuselages and wings had to be carried down the sides of hills by manpower or on mule-back.

Whilst underground facilities no doubt provide a high degree of immunity for the manufacturing activities concerned, they cannot be considered completely satisfactory in every respect. Difficulties were experienced both by the Germans and Japanese in the elimination of water seepage, corrosion, noise, gases, dust, falling dirt and rocks. Furthermore, large as they were, these plants produced only small and medium-sized aircraft and afford no insight as to the potential suitability of underground construction of aircraft the size of the Boeing B-29 "Superfortress" or the Consolidated B-36.

More important, however, is the fact that a broad segment of supporting and related activities must be housed within the underground sites. This includes electric power, gas and coal, water, forge and foundry. In addition, underground storage of raw materials and required finished components should be available to enable the factory to operate for at least two weeks without the need for new deliveries. This would provide some degree of insurance against interrupted surface transportation facilities.

These considerations apply to conditions of aerial bombardment as practiced in World War II. In a future war the use of the atomic bomb may produce an entirely different picture, as such bombs may possibly be used primarily against targets which are difficult to place underground, such as steel and aluminium plants, transportation centres, docks and similar objectives. P. A. B.

Tunnels literally honeycombed ground beneath runways of airfield at Atsugi, Japan ; they were used as storage depot for ammunition, aircraft parts, machine tools, food, clothes.

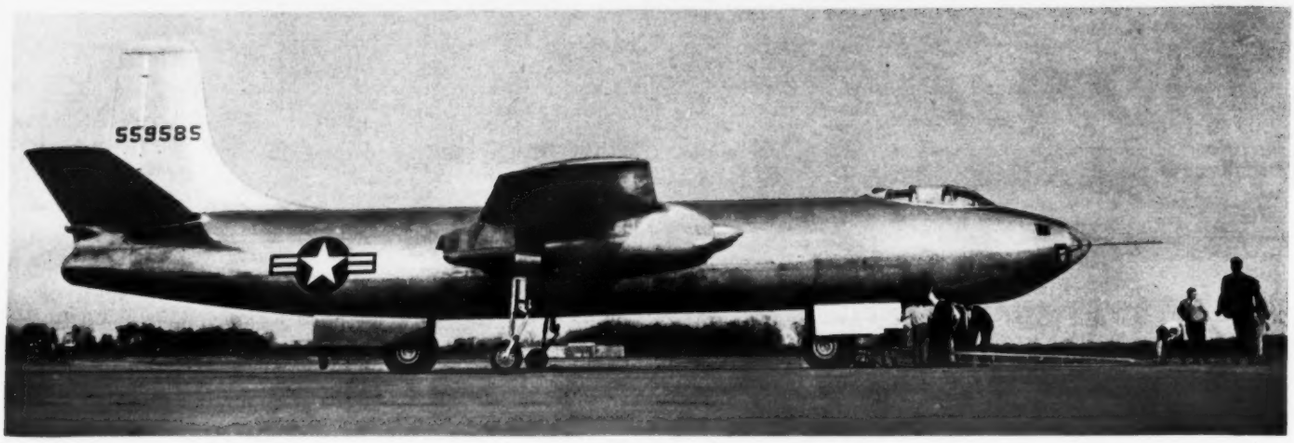


MARTIN XB-48

The latest addition to the U. S. Army Air Forces' jet programme is the XB-48, a six-engined bomber built by The Glenn L. Martin Co., Baltimore. The prototype effected its first flight at the end of last June, when it flew from the factory airfield to the Navy's proving ground, Patuxent River. Quite a number of similar multi-engined aeroplanes are being built for the AAF by other aircraft manufacturers. Though still subjected to secrecy regulations, it is likely that a number of them will be completed and flight-tested during the course of this year.

The six General Electric TG-180 turbo-jets powering the XB-48, licence-built by Allison under the designation of J-35, are located in groups of three in two nacelles which extend beyond the leading and trailing edges of the wing. The external shape of the engine cowlings are strongly reminiscent of the cowlings for piston engines ; and one would not be far wrong in assuming that it was originally intended to power the XB-48 with Pratt & Whitney "Wasp Major" four-row radials of 3,000 H. P. each. It is clear from the performance data that the present turbines are not powerful enough (the J-35's thrust is probably not more than 2,000 lbs.) ; and whilst these data have not yet been confirmed fully in flight, the calculated figures are all the same inferior to those of the North American XB-46 four-engined medium jet bomber. Meanwhile, it may safely be assumed that more powerful turbines will be fitted to the XB-48 as soon as such are available.

Despite this disadvantage, however, the XB-48 has revealed a top speed of not far below 500 m. p. h. ; payload is quoted at 10 tons, which is perhaps a little too optimistic, whilst no statement has been made on range. Besides the tare weight of 58,500 lbs., the following data may be listed : span, 108 ft. 4 in. ; length, 85 ft. 9 in. ; height, 27 ft. 6 in. ; and wing area, 1,300 sq. ft.

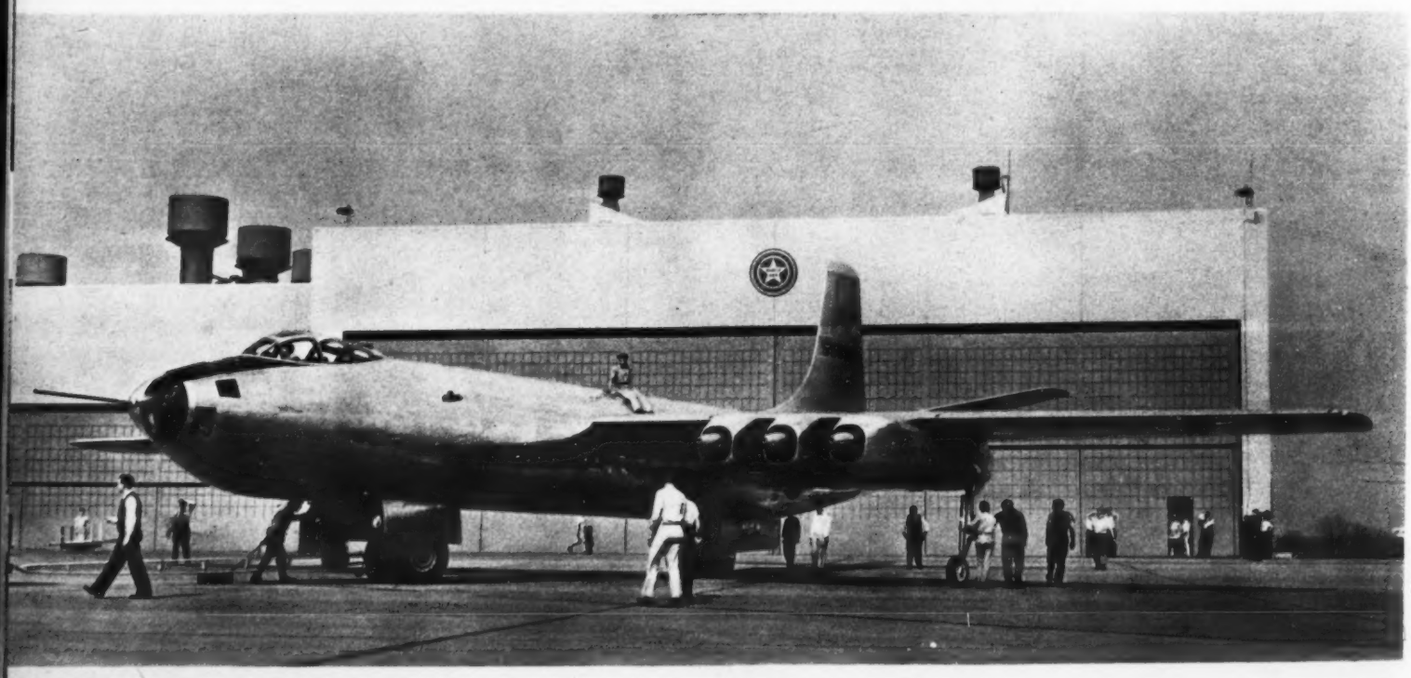


One of the most interesting features of the XB-48 is its novel undercarriage. The development of modern high-speed aircraft requiring the thinnest possible wings has confronted designers with a new problem : the wings of heavy high-speed bombers leave no room for the extremely large landing-wheels to retract, and the latest introduction of pure jet engines has ended the former possibility of housing the wheels in the rear portion of the engine nacelles.

Whilst most aircraft manufacturers are endeavouring to solve this problem by developing particularly thin high-pressure tyres, Martin has built something entirely new in the way of landing gear. This was tried out originally in the Martin B-26 "Marauder" twin-engined bomber, one of the war veterans. Instead of attaching the wheels to the wing surfaces, Martin has fixed them to the actual fuselage. In order to avoid, to as great an extent as possible, a displacement of the centre of gravity whilst bombs are being dropped, the wheels are arranged in two pairs and positioned fore and aft of the bomb-bay, in the plane of symmetry of the fuselage. An extremely light supporting wheel is located beneath the outboard engine of each outer wing, thus fulfilling the same function as lateral floats on flying-boats and lending the necessary stability during taxi runs. The ailerons are quite effective even at low-speed taxi runs, so that the supporting wheels are mostly used for turning on the ground and whilst the aircraft is at a standstill.

Hence, it has been possible to keep the tyres and legs for these supporting wheels to small dimensions, so that they can easily be folded sideways and inwards and retracted into the rear part of the outboard turbines' nacelles. According to Martin, it is possible to keep the weight of a tandem landing gear considerably below that of an ordinary nose-wheel or tail-wheel type. Logically enough, the small dimensions of the tandem model permit an appreciable economy in weight.

Thorough taxi trials have proved that the new Martin landing gear is every bit as stable as a conventional undercarriage ; and in fast taxi trials with a B-26, it was found to be almost impossible to tip the aircraft over, even on sharp curves. Meanwhile, it might be jumping to conclusions to state that such landing gear could easily be fitted to commercial transports. An installation of this sort would be mainly contingent upon the distribution of space in the fuselage, as it is the bairline operator's aim to devote every cubic foot to passenger or freight accommodation. At all events it will probably be some time before the designers of airliners find themselves confronted by the same difficulties which led Martin to develop the tandem landing gear for the XB-48. *Bi.*



The Grande Hotel operated at Belem, Brazil, by Intercontinental Hotels Corporation, subsidiary of Pan American World Airways.

AIRLINE HOTELS

It is a commonplace to state that "flying is the fastest way of travelling." But even at today's flying speeds a trip aboard a modern airliner halfway around the world takes a few days and usually includes one or more overnight stops.

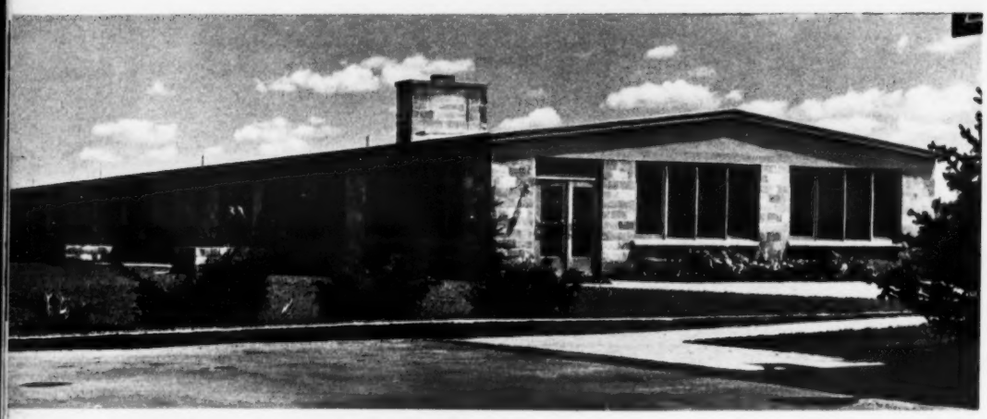
The fact that such stops are made—much to the relief of the passengers, who usually are quite happy to break the journey after ten or fifteen hours in the same aircraft—has convinced the major long-distance airlines, Pan American World Airways, British Overseas Airways, KLM Royal Dutch Airlines, and others, of the necessity to provide suitable overnight accommodation for their passengers. This is but one of the reasons why specialized aviation hotels have come into existence. Another is that in large cities with numerous hotels, a traveller can obtain accommodation with comparative ease. Unfortunately for him, the landing points on some of today's intercontinental air services are somewhat "in the sticks," and hotel rooms are scarce. This applies mainly to the British air services to Africa and the Far East and the American routes across the Pacific. Again, post-war air travel has created a tourist boom in some parts of the world : the welcome mat is always out, but often there is no room behind it. This is the case especially in Latin America, which is swarming with North American tourists. In 1946, Pan American alone carried a total of 738,850 passengers to Latin America, an 89-percent increase over the 1945 total. Owing to recent fare cuts on its routes to South America, the 1947 figures will be considerably higher. Finally, hotels are operated at certain terminal airports for passengers arriving from overseas on one line and proposing to continue to their destination on another the next day.

Pan American Airways is gradually becoming one of the largest hotel operators in Latin America. To take care of this expanding business, P. A. A. last winter organized a wholly-owned subsidiary, the Intercontinental Hotels Corporation. This company either operates its own hotels or gives technical and financial assistance to local companies undertaking hotel construction projects in areas where accommodation for air travellers is inadequate or strained to capacity.

As the passenger traffic to Latin America now includes a very large proportion of tourists, Pan American Airways has taken pains to ensure a high degree of luxury for its patrons. In *San Juan*, Puerto Rico, the airline signed a long-term lease on the six-storey, 36-room *San Geronimo Hotel*, now known as the Pan American World Airways Guest House, and spent *more than* $ 58,000 modernizing and redecorating it.

In *Belem*, Brazil, PAA has taken over the management of the 115-room *Hotel Grande*, where many travellers pause en route between Buenos Aires and New York. At the present

Side-walk café of P. A. A.'s Grande Hotel, Belem, Brazil.

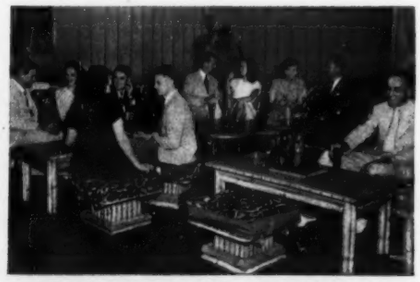


The "Sky-Tel" at Bradley Field, Boise, Idaho.

Reception desk at Prestwick Airport Hotel, Prestwick, Scotland.

Part of dining room at Prestwick Airport Hotel.

Lounge at B. O. A. C. resthouse at Korangi marine air terminal, Karachi, India.



Lounge-bar at P. A. A. guest house at Piarco Airport, Port of Spain, Trinidad.

time the airline is refurnishing and air-conditioning the entire building. The hostelry has an interesting background : it was once the Palace Theater, and the great Russian dancer, Anna M. Pavlova, performed there before the turn of the century. Later it became a gambling casino and finally a luxury hotel. It has meanwhile grown into the social and civic centre of Belem. In over-crowded *Rio de Janeiro*, PAA has leased three floors of the *Hotel Regente* on famous Copacabana Beach.

In *Port of Spain*, Trinidad, P. A. A. took over and redecorated the war-time barracks serving as intermediary stopover for air crews ferrying military aircraft across the South Atlantic to the Middle East Today it has 25 double rooms, and 20 more are being added. The Port of Spain guest house and the adjoining staff house, where P. A. A. Clipper crews are quartered, is operated by a total of 79 employees, including Chinese cooks, East Indian waiters, bellhops and chambermaids.

At *Miami*, Florida, the starting point of P. A. A.'s services to the South, the company is guaranteeing its Latin American patrons the finest in accommodation at reasonable rates through an arrangement to keep more than 100 rooms reserved daily at leading hotels the year round. — The PAA's Intercontinental Hotels Corporation has only just started its activities and proposes to extend them considerably in order to keep abreast of flying operations in its efforts to beat the resulting room shortage.

The hotel accommodation provided to its passengers by *British Overseas Airways Corp.* at many places all over the world is of a more functional nature and less designed for the luxury-loving tourist than the hotels run by its American competitor, P. A. A. This does not mean that the B. O. A. C. hostelries do not afford a high degree of comfort : on the contrary, they include all modern conveniences but are chosen for very practical reasons and rarely situated in sight-seeing centres.

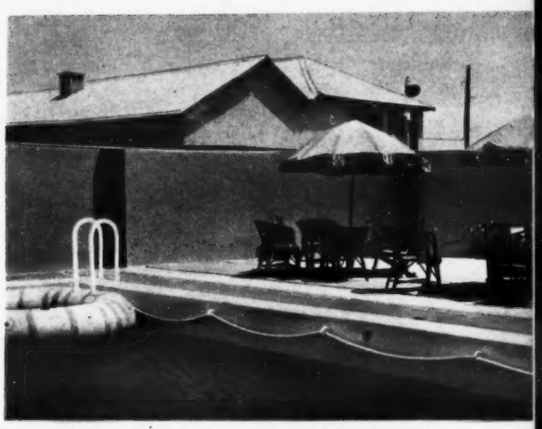
At *Karachi*, the important airline junction in India, B. O. A. C. runs two resthouses. One is situated at Karachi Airport and contains 24 air-conditioned rooms, to which 30 more will shortly be added. An especially welcome feature in that torrid area are artificially cultivated lawns and flower gardens. The second resthouse is situated at the *Korangi* marine air base, and comprises 47 bedrooms in eight sleeping blocks, a well-stocked bar, dining room and lounges decorated in the old English style. It also includes a fresh-water swimming pool and a squash court for energetic travellers.

Another resthouse is operated by BOAC at *Bathurst*, capital of the Gambia, Britain's oldest colony on the West Coast of Africa

General view of B. O. A. C. hotel at Bahrein, in Persian Gulf.

One of B. O. A. C.'s coaches used for carrying passengers from airport to town or to guest house. This one is stationed at Bahrein.

B. O. A. C. resthouse at Fajara, near Bathurst, in the Gambia, West Africa.



Passengers' Swimming Pool at B. O. A. C.'s Korangi marine terminal, Karachi.

and one of the major South Atlantic terminals ; the hotel is virtually a self-contained village 16 miles from Yundum Airport and 11 from Bathurst proper and has its own electricity plant, water supply and workshops. The passengers sleep in individual chalets on the beach. In close proximity is the Benders Arms, a replica of an old English Inn, which is becoming world-famous as a meeting place for passengers, B. O. A. C. staff and European residents of Bathurst.

Another good example of a B. O. A. C. resthouse is that at *Manama*, capital of Bahrein Island, the arid petroleum centre in the Persian Gulf. It is built of coral rock and is air-conditioned throughout. Work will be started shortly on an additional air-conditioned resthouse containing 37 rooms. It should be completed in about 18 months. — Other B. O. A. C. resthouses are those at Margil Airport, Basrah, in 'Iraq, as well as the famous houseboat "Mayflower" which is moored in the Nile near Cairo, Egypt.

A pleasant airport hotel for passengers changing from one airline to another is that at *Prestwick,* in Ayrshire, Scotland. The hotel building also comprises the control tower and the booking offices of numerous European and American airlines. It has extensive dining and breakfast rooms, a bar, and accommodates about 70 passengers. A hotel of similar type is the Airport Hotel at *Croydon,* near London, which has just been reopened after serving as an RAF officers' mess throughout the war. It has lost much of its importance due to the transfer of most of the major air services to the airports at Northolt and Heath Row.

Finally, an American initiative, which may prove worth imitating : an ultra-modern airport hotel, abbreviated in the American way to "Sky-Tel," has recently been opened at *Bradley Field,* near Boise, Idaho. It is specially designed to relieve touring pilots proposing to stay the night of the necessity of rustling transportation into town and hunting for a room. Clean, comfortable, it has thirteen rooms and anad joining restaurant.

This small glimpse into the ground accommodation problems facing the airlines shows up one fact : the operating companies have realized that air travel is not just flying from one point to another, dumping passengers on the airport. If the air traveller's goodwill is to be maintained, he has to be taken care of and convinced that airlines do not only provide speedy travel, but also a certain degree of comfort when he leaves the aircraft after a long and tiring flight. P. A. B

Book Review

Thermodynamique des Systèmes Propulsifs à Réaction et de la Turbine à Gaz.

By Maurice Roy. Published by Dunod, Paris, 1947.

Dealing primarily with thermodynamic problems in turbojets, propjets and rocket units, expressly omitting the constructional materials, the book is a summary of a lecture delivered by the author in 1946 before the "Centre d'Etudes Superieurs de Mechanique" in Paris.

The first two chapters deal with the main fundamental laws of aerodynamics and individually examine thermodynamic problems in connection with separate subassemblies of turbojet engines, for instance, the thermodynamic processes in the vane-grid flow in the case of axial-flow compressors, both in the combustion chambers and the exhaust jet nozzles.

One chapter is specially devoted to rocket propulsion, again stressing the thermodynamic processes for liquid and solid fuel rockets.

As regards pure jet engines, the author thoroughly describes the influence of compression ratio on compressor and turbine efficiency, and the power increase due to water injection.

The final chapter is a special one on gas turbines, describing, among others, systems with intercooling, and open and half-open circuits.

The book's value is enhanced by the addition of numerous, well-chosen examples of application.

160 pages ; price, Fr. fr. 540.— (French.) *Ba.*

Beitrag zur Theorie feststehender Schaufelgitter.

By Richard Meyer, D. Sc. Mitteilungen aus dem Institut für Aerodynamik an der Eidg. Techn. Hochschule in Zürich, Nr. 11. Published by A. G. Gebr. Leeman & Co., Zurich, 1946.

Forming the author's doctor-dissertation, this book is primarily for turbine engineers. It deals on a purely theoretical basis with the three-dimensional potential flow through a fixed axial vane-grid. Generalising a method for mathematical definition of the flow through plane vane-grids, developed by Prof. Ackeret (J. Ackeret : "Zum Entwurf dichtstehender Schaufelgitter," Schweiz. Bauzeitung, 1942), the author gives the first exact description of the potential flow through three-dimensional axial vane-grids. He begins with a thorough approbation of Ackeret's method (which replaces the vanes with suitably-chosen systems of vortices and sources), follows a short introduction to the theory of real cylinder functions with an examination of the influences of annular vortices, and concludes by describing the grid flow ; as example, the velocity field of a vortex plane placed perpendicular to the axis is calculated. The annexe is devoted to the proper values, the calculation of which plays an important rôle in the case of a numerical execution of the method described in this book. (German.) *F. P.*

Transocean Flight Attempts.

Compiled and published by Arthur Flury, Berne, 1946.

A recently-published book on aviation, of which the contents are, on the whole, fairly accurate, postponed Lindbergh's Atlantic flight to April, 1928 ; the idea was to prove that the pioneers' flights across the oceans are already historical items—witnesses to an aviation epoch which has been terminated and replaced by scheduled transocean commercial flights. Flury set himself the task of reporting in detail all successful and unsuccessful transocean flight attempts so far made : three tables contain valuable data on 78 westbound North Atlantic flights, 105 eastbound North Atlantic flights, 64 South Atlantic and 43 Pacific flights—290 in all.

Aviation speaks in many tongues : Flury's explanations are in English, French and German. *He.*

VIA (Routes, Aéroports, Tourisme).

Magazine published four times a year by Société Internationale d'Editions Techniques, Paris.

This carefully-edited and profusely-illustrated magazine, published under the direction of Ludovic Flandrois, has, as aim, to re-animate the French tradition of highway construction and tourist accommodation. It is divided into three parts : Highways, Airports, and Tourism. The articles in each part are from the pens of experts of international repute. The quality of the illustrations, paper and printing in the first issues are a credit to the publishers, for "VIA" gives no evidence of the current shortage of materials in France. Its interesting contents are bound to contribute in a good measure towards the French reconstruction effort. (French, with certain articles in English and translation). *He.*

Official Bulletin of the F.A.I.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

Election of the Directing Committee.

Members are reminded that the Directing Committee of the F. A. I. is elected annually at the General Meeting (Art. 22 of the Statutes, page 27). Aero clubs wishing to present a candidate should inform the General Secretariat one month before the General Meeting in Geneva (Regulations, Art. 15, page 33), thus before August 17th, 1947.

Appointment of Commission Members.

Members are appointed to the Commissions annually at the General Meeting. National aero clubs not represented on the Commissions and wishing to have permanent delegates should name their candidates in good time so that the appointments may be approved by the General Meeting (Regulations for Commissions, Art. 32, page 37).

Record homologated by the F. A. I. : Women, Class C.
Speed over standard 3-km. course (U. S. A.).

Miss Margaret M. Hurlburt. (Killed whilst giving aerobatic display at Deborah, Iowa, on July 4th.)

Aircraft : Chance Vought "Corsair."
Engine : Pratt & Whitney R-3800-8 of 2,000 H. P.
Tampa, Florida, March 16th, 1947 — *543.362 km/h.*

PICAO Monthly Bulletin, May, 1947.

(Last bulletin before going over to ICAO.)

The following extracts from the bulletin may be of interest to national aero clubs :

The session of the Operating Practices Division (OPS) recommended :

that an aircraft flying over another State may not be required to land except in very exceptional circumstances, which are reportable to ICAO ;

that the form and contents of the journey log book to be used on international flights be standardised ;

that each State adopt two working languages for use in air-ground communications.

Languages in Radio Telephony.

Radio telephone communications with aircraft should be primarily in the language of the State in which the aircraft is operated, with English as the alternative language. When the aircraft is flying over an English-speaking State, however, the second language should be either French or Spanish, the choice being determined regionally.

THE MONTH IN REVIEW

Copyright by INTERAVIA *

POLITICAL

● AVIATION AGREEMENTS have been concluded between : *Hungary and Yugoslavia*, on June 23rd in Belgrade ; *Iraq and Turkey*, in Ankara ; *Sweden and Canada*, on June 27th in Ottawa. — On June 28th the *U. S. and Portuguese Governments* signed a Civil Aviation Agreement amending that signed in December, 1945. The revised text gives Portuguese aircraft landing rights at Boston and Miami, as well as New York.

NEW AIRCRAFT

● The prototype *Martin XB-48* six-engined jet bomber made its *first flight* from The Glenn L. Martin Co.'s factory airfield on June 22nd.

Float version of the Aeronca "Scout" two-seater tourer.

● Aeronca Aircraft Corp. of Middletown, O., have announced a new two-seater light aircraft, the *Aeronca "Scout,"* which is basically a more simply equipped and cheaper version of the Aeronca "Chief" two-seater. Available with fixed conventional undercarriage, or with floats, and powered with a 65-H. P. flat-four, the "Scout" has a top speed of 100 m. p. h. and a cruising speed of 90 m. p. h. Sales price, $ 2,475.

● On June 17th, 1947, the French national SNCA du Sud-Ouest aircraft concern's prototype *SO 30R-2* twin-engined transport made its *first flight*. The SO 30R-2 is a twin fin and rudder version of the SO-30R feeder plane.

SO 30R-2, second prototype of the SO 30R twin-engined transport of SNCA du Sud-Ouest.

● During the second half of June SNCA du Sud-Ouest also flew their *SO 7050* for the first time. This is a light plane which is intended for the design competition for 75-H. P. two-seaters ; it is powered with the Mathis 4 G 60 flat-four of 75 H. P.

SO 7050 two-seater tourer of SNCA du Sud-Ouest.

● On June 18th the *Portsmouth "Aerocar"* twin-engined light transport built by Portsmouth Aviation Limited, made its *first flight*.

* Excerpts from Nos. 1325-1335 (June 24th to July 17th, 1947) of "INTERAVIA, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in four language editions, English, French, Spanish and German.

● The first of the *Boeing B-50* four-engined very heavy bombers built by Boeing Aircraft Co. made its *first flight* on June 25th from the firm's airfield at Seattle. Piloted by A. Elliott Merrill, Boeing's test pilot, and carrying six other crew members aboard, the B-50 remained in the air for 1 hr. 38 min. Maximum speed in the vicinity of 400 m. p. h. is estimated.

● The second prototype of the *Northrop XB-35* four-engined "all-wing" bomber recently made its *first flight* under unexpected circumstances. Whilst on what was intended to be a high-speed taxi run, it began to lift off the ground. Assured that everything was functioning correctly, test pilot Fred Bretcher allowed the aircraft to continue its flight and landed it half an hour later at the USAAF experimental base at Muroc.

● Westland Aircraft, Ltd., of Yeovil, Somerset, recently demonstrated their *"Wyvern T. F. I."* high-power Naval strike-fighter. All-metal low-wing monoplane with slight gull-wing, its armament consists of 420-mm cannon ; a bomb load of 2,000 lbs., eight rocket projectiles and one torpedo slung under the fuselage can also be carried. Powered with a Rolls-Royce "Eagle" air-cooled 24-cylinder sleeve-valve in-line engine of 3,500 H. P. driving a Rotol eight-blade contra-rotating airscrew, the "Wyvern" has a top-speed of 455 m. p. h. and a cruising speed of 295 m. p. h., at an all-up weight of 22,000 lbs.

● *Baumann Aircraft Corp.* have moved their *Baumann "Brigadier Two-Fifty"* twin-engined personal aircraft with pusher airscrew to Metropolitan Airport, Van Nuys, for its test flights. On June 28th the prototype undertook its *first flight*.

Westland "Wyvern T. F. I." torpedo fighter.

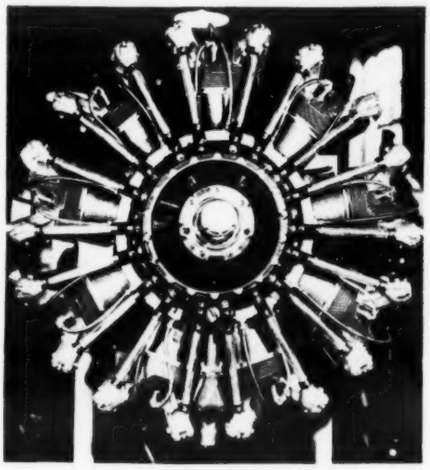
● The prototype *Boeing 377 "Stratocruiser"* four-engined commercial transport made its *first flight* on July 8th from Boeing Aircraft Co.'s factory airfield at Seattle. John Fornasero, Boeing's test pilot, took off with a gross weight of 100,000 lbs. (35,000 less than the max. permissible take-off weight) and stayed in the air for 1 hr. 24 min.

First flight of Boeing 377 "Stratocruiser".

● The prototype *Airspeed A. S. 57 "Ambassador"* twin-engined commercial transport made its *first flight* on July 10th over the airfield of Airspeed, Ltd., at Christchurch, Hants. G. B. S. Errington, Airspeed's chief test pilot, and J. Pears, flight engineer, stayed in the air for 45 min. and expressed their general satisfaction with the aircraft's performance.

POWER PLANT

● *Instituto Aerotécnico de Córdoba*, the Argentine concern, has developed an air-cooled nine-cylinder engine, the *"El Indio,"* of 600 H. P. rated power at 2,250 r. p. m. and boost pressure of 5.65 lb./sq. ft. Maximum diameter is 47.28 in. ; bore, 5.52 in. ; stroke, 5.52 in. ; total swept volume, 1,155 cu. in. ; and compression ratio, 6.4.



"El Indio," nine-cylinder radial of 600 H. P.

● *Wright Aeronautical Corp.* and the *Pratt & Whitney Aircraft Division* of United Aircraft Corp., the two most important U. S. aero-engine manufacturers, are engaged in *development work directed towards increasing the performance of piston engines by the introduction of the compound turbo- and piston-engine principle.* "Compounding" is said to use the energy of the exhaust gases (hitherto lost or used only for the turbo supercharger or for ejector exhaust) to drive a gas-turbine transmitting the power back to the crankshaft. Up to now, model tests have shown that such compound engines may be expected to give a *fifteen per cent increase in efficiency.*

INDUSTRY

● *Ryan Aeronautical Co.*, San Diego, which has purchased manufacturing facilities and rights of the *North American "Navion"* four-seater personal aircraft, anticipates starting production in the autumn. It is intended to retain the name "Navion" and to market the aircraft at its present price of $ 7,750.

● The *Chance Vought Division* of the United Aircraft Corp. celebrated its *thirtieth anniversary* on June 21st. Several products of the firm were demonstrated publicly on this occasion, including, for instance, a new and improved version of the well-known F4U-4 "Corsair" fighter, known as the *F4U-5 "Corsair"* ; the *V-173*, which is full-scale model of the *Chance Vought XF5U-1 "Skimmer"* twin-engined experimental single-seater Naval fighter, a "flying-wing" type of circular periphery ; and the *Chance Vought XF6U-1 "Pirate"* single-seater Naval jet fighter.

INTERNATIONAL ORGANISATIONS

● IATA : The *North Atlantic Traffic Conference* of the *International Air Transport Association*, which met in New York on June 24th, decided to retain the present

tariff to the end of February, 1948. Consideration was given to the introduction of a special winter tariff with reduced rates. The conference will meet again on November 17th, and lay down fares for the whole of 1948. A special Committee from IATA is to make contact with the North Atlantic Shipping Conference to facilitate air passengers returning by sea and vice-versa. The Conference also recommended the abolition of the various air freight classifications and the standardisation of discounts (up to 25 % for regular shipments of over 100 lbs.) ; a special discount was recommended for travel agents travelling to build up group excursions.

AIR TRANSPORTATION

● ATLANTIC : *British Overseas Airways Corp.* has intensified its *London—Prestwick—Montreal* service from one to two round flights weekly, which means that the carrier is now flying eight round flights a week with a fleet of only five Lockheed "Constellations." With aircraft on the New York service having to fly a "dead" leg from New York to Montreal for maintenance, present schedules give very little margin in aircraft utilisation, and accentuate BOAC's need to obtain additional flying equipment. — *Air France* has received its first "Constellation 749" fitted with 22 berths and, coincident with the first flight of this aircraft, has intensified the *Paris—New York* service from four to five return trips weekly. — *Scandinavian Airlines System*, the joint group of Nordic carriers, plans to inaugurate a once- or twice-weekly service to *Montreal* in October. — The Government of the Canadian Province of *Ontario* is negotiating with *Transocean Airlines*, the non-scheduled carrier based at Oakland, Calif., for the transport of 7,000 immigrants to Canada from Great Britain. It is planned to organise two departures daily in August, September and October, with DC-4's each carrying forty passengers. — *Flota Aerea Mercante Argentina (FAMA)*, the Argentine state-controlled carrier, opened a *Buenos Aires—Madrid—Barcelona—Rome* service on July 9th. DC-4's are being operated.

● On June 20th *American Overseas Airlines* extended its Scandinavian service to *Helsinki*. As Helsinki airport is not suitable for AOA's Douglas DC-4's, passengers for Finland have to change over to DC-3's in Stockholm. Three of AOA's five weekly schedules to Scandinavia now connect with Helsinki.

● *A. B. Aerotransport*, the Swedish carrier, was scheduled to make a *survey flight* over the *Stockholm—Copenhagen—Berlin—Prague—Vienna—Budapest—Belgrade* route between July 20th and 28th.

● It was reported from Sofia on June 23rd that the *first Bulgarian domestic airline services* were to be started on June 29th.

● According to an official Soviet announcement, there are *200 passenger and freight services in the 28,000-mile route network of airlines in the Ukraine*. It is also stated that some 200 aircraft are being used for pest control in this region, in order to safeguard the sugar beet harvest.

● On July 3rd and 4th the French National Assembly discussed the 1947 *Ordinary Budget for the Secretariat General of Civil Aviation and Air Transportation*, which totals fr. 4,171,000,000 (1946 : fr. 2,658,000,000.) The reason for this high figure is because France does not wish to be behind other countries in civil aviation. The 104 airports opened to civil air operations in the French Union since the war is to be increased to 165 in 1947. In 1938 there were 60 such airports. *Credits for airports and ground services* have been increased from fr. 82,000,000 in 1946 to frs. 202,000,000.

● The re-introduction of the sum of frs. 15,000,000 by the French National Assembly for the French Ministry of Posts makes it possible for *Air France* to keep up its *nightmail services*. A decree terminating the Paris—Nice service has thus become non-effective.

● The *British Post Office* anticipates starting *long-distance inland night airmail services* within the next twelve months. Inauguration of such services has so far been held up by the lack of up-to-date night flying aids.

● On July 5th the Allied Occupational Authorities sent a note to the Italian Government authorising *Italian civil aircraft to resume services abroad*.

● The Dutch Government has authorised *KLM Royal Dutch Airlines to increase its capital to Fl. 100,000,000*, to finance its expansion programme and, in particular, to procure new aircraft. At the same time a Bill has been introduced in the Dutch Parliament to empower the Government to take up a maximum amount of Fl. 51,000,000 of KLM's authorised capital, and to grant or guarantee loans to the airline of up to a maximum of Fl. 50,000,000. Under a draft agreement between the Government and KLM, the State will only hold Fl. 40,000,000 worth of shares for the time being ; in principle, however, it will continue to hold a majority interest.

● *KLM Royal Dutch Airlines and KNILM Royal Netherlands East Indies Airways have merged*. The thus reorganised KLM will gradually take over the air operations in Dutch East Indies at present operated by KNILM, the Dutch Ministry of Communications and the transport organisation of the Dutch Air Force. — Following discussions with KNILM, the Indonesian authorities have decided to form an *Indonesian national airline concern* in the near future.

● With a view to developing its European network *Swissair* has ordered *four "Convair-Liner"* twin-engined transports (formerly known as Convair 240's). All four aircraft are to be pressurised and should be delivered by Spring, 1948.

● On July 19th *BOAC* cancelled the thrice-weekly *London—Lagos* service operated with DC-3's and *intensified* the service it operates with Handley Page "Haltons" over this route, from three to five trips weekly. A sixth round trip will be added in August. Instead of flying via Casablanca and Dakar, the service is being flown *across the Sahara desert via Algiers and Kano*.

● According to the U. S. Civil Aeronautics Administration, *violations by airlines of civil air regulations since July 1st, 1946*, have caused eight companies to pay *fines totalling $ 19,000*.

● AIRPORTS : On July 9th Lord Nathan, British Minister of Civil Aviation, stated in the House of Lords that *43 British airfields* outside the London area are to be acquired by the State *for civil aviation*. Many fields are already in use as civil airports, but are owned by private companies ; most of the others are R. A. F. bases which will require considerable development. — The *Belgian ground organisation administration* (Regié des Voies Aériennes) has been allocated frs. 268,000,000 for urgent work ; the major part of this sum is for *Melsbroeck Airport*, Brussels, and the alternative fields at Raversijde and St. Hubert. It is hoped to have Melsbroeck completely equipped by the end of this year. — The Egyptian Government is contemplating *consolidating all civil aviation operations at one of Cairo's two airports*, and handing over the other to the Royal Egyptian Air Force. It seems likely that *Farouk Field* will be chosen as the civil airport, as the pre-war facility at *Almaza*, which is the operating base of Misr Airlines, is inadequate for large four-engine transports. — The Government of *Northern Rhodesia* is studying a programme involving the expenditure of £ 414,000 over a three-year period for *airport facilities* in the country. The scheme forsees a terminal airport at Livingstone costing £ 250,000, four first-class all-weather airports on the main trans-Africa trunk route, and a number of emergency landing grounds.

AIRLINE PERSONALITIES

● The Port of New York Authority appointed *Hervey F. Law* as its *Director of Airports* on June 16th. Well experienced in airport development questions, Law was previously Manager of Washington Airport, in which capacity he succeeded in doubling the airport's revenue in the last three years.

● *M. I. Rahim* has been appointed *Director-General of Indian Civil Aviation* in succession to Sir Frederick Tymms.

SERVICE AVIATION

● General Clement S. McMullen, Deputy Commanding-General, Strategic Air Command, stated in Washington on July 8th that the frequency of *training flights with B-29 "Superfortress"* heavy bombers to *Europe and the Far East* is to be increased so that one flight will be made each month ; aircraft will stay for some time in the Zones of Occupation for operational training.

● The *Turkish Government* has purchased and taken delivery of *eleven Boeing B-29 "Superfortress"* bombers.

● On July 10th the French Cabinet laid down that the *allocation for Defence* in the Ordinary Budget should be Fr. 84,689,000,000, distributed as follows : Ministry of War, Fr. 37,117,000,000 ; *Air Ministry, Fr. 13,700,000,000* ; Navy Ministry, Fr. 11,172,000,000 ; Defence Ministry, Fr. 1,500,000,000 ; and Ministry for French Overseas Possessions, Fr. 21,200,000,000.

● During the French railway strike from June 8th to 12th, *Groupe de Moyens Militaires de Transports Aériens (GMMTA)*, the military air transport organisation, transported 1,500 passengers and flew 4,600 miles.

● The Danish High Command has opened a *courier service* with military aircraft between *Copenhagen and Jever* (Oldenburg ; 9 miles northwest of Wilhelmshaven) ; the latter locality forms the headquarters of the Danish Brigade of Occupation Troops and was formerly a Luftwaffe base. The service is also used to train Danish military pilots in long-range flying.

● *Lieutenant-Colonel L. A. Wilmott*, Deputy-Director of the South African Air Force, was killed on June 26th, when a de Havilland "Mosquito" he was piloting crashed near Pretoria.

PRIVATE FLYING

● The *U. S. National Air Races at Cleveland*, Ohio, will be held on August 31st and September 1st. Frederick C. Crawford, President of the Air Races, has announced that the U. S. State Department has authorised *teams from Canada and Mexico* to be invited to participate.

PHOTO CREDITS :

Cover Page : General Electric Co. ; P. 12-18 : A. U. Schmidt (6), Martin & Kelman (2), Interavia Archives (1), General Electric Co. (7), USAAF (2), Johns Hopkins University (1) ; P. 19-22 : Georges Février (25) ; P. 23-25 : Blackburn Aircraft Ltd. (4) ; P. 27-31 : Author ; P. 32 : Boeing Aircraft Co. ; P. 37-39 : Airwork Ltd. (3), Interavia Archives (1) ; P. 40-42 : Manufacturers (7) ; P. 44-48 : Arthur Shay (12), USAAF (1) ; P. 49-50 : USAAF (8) ; P. 51-52 : Interavia Archives (3), Martin & Kelman (1) ; P. 53-55 : P. A. A. (3), B. O. A. C. (4), Scottish Aviation (2), British Crown Copyright (1), Interavia Archives (1) ; P. 57-58 : Martin & Kelman (1), "Flight" (1), Manufacturers (7).

AVIATION **Esso** PRODUCTS

Serving Aviation Everywhere

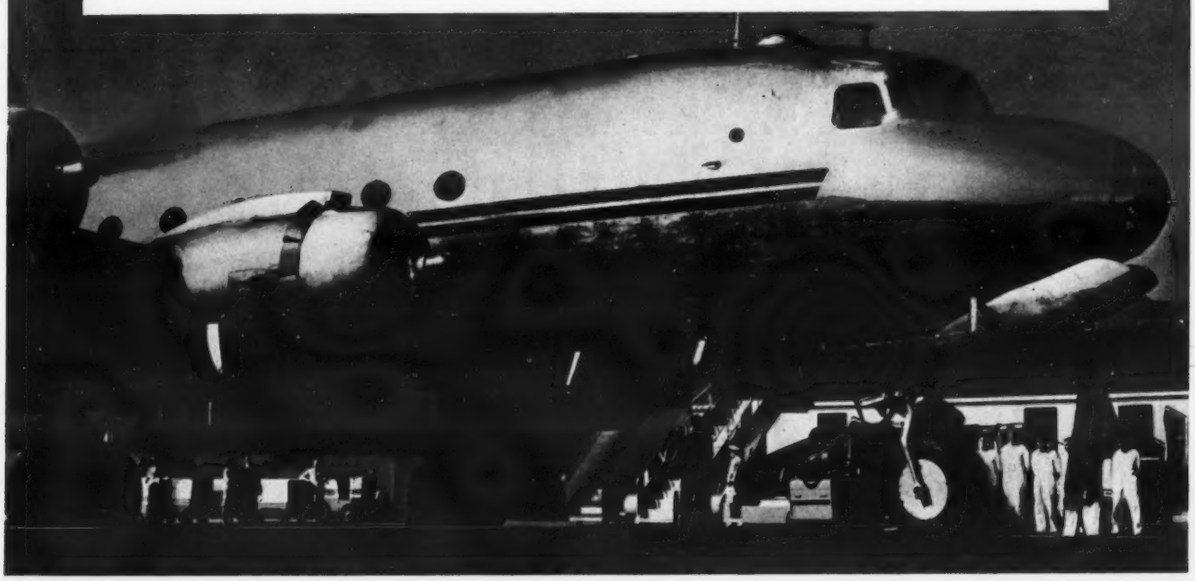
In the near future the world famous Esso Oval, which is the symbol of the highest quality petroleum products, will appear along the airways of the world.

Mobiloil
AERO

This Sign is Your Guarantee —

of quality aviation products backed by eighty-one years of experience—greatest in the oil industry.

Mobiloil Aero, first used by the Wright Brothers on their historic flight, has lubricated the flights of many other well-known air pioneers.

Socony-Vacuum aviation greases, instrument and hydraulic oils, and Mobiloil Aero provide air line operators with a complete range of flight-tested aviation lubricants.

SOCONY VACUUM OIL CO, INC.